Printed on Thin Paper for Foreign Circulation.

The Engineer.

Established 1856. Registered as a Newspaper.

OFFICE FOR ADVERTISEMENTS & PUBLICATION, 28, ESSEX ST., STRAND, LONDON, W.C. 2.

VOL. CLIV.—No. 4009] LONDON: FRIDAY, NOVEMBER 11, 1932 [PRICE ONE SHILLING BY INLAND POST 1s. 3d.

PUBLIC NOTICES.

Civil Engineering

ASSISTANTS (TWO) REQUIRED for Directorate of Works, The War Office. For one post (Barrack Design, Steel Work Section) candidates must have undergone graduate course of civil or structural engineering as defined by Institutions of Civil or Structural Engineering, and must be under 30.

For second post (Fortifications Section) candidates must have had experience of fortifications work and must be under 45. Preference will be given to men, with the requisite qualifications, who have served in the Royal Engineers.

Salary of both appointments £140 to £200 plus Civil Service bonus, making total commencing salary £196 18s.

Applications, specifying for which post candidate desires to be considered, to be made not later than 23rd November on form to be obtained from the UNDER-SECRETARY OF STATE (C.5.), The War Office, London, S.W.1. 9137

Armourers' and Brasiers' Company

IN THE CITY OF LONDON.

LECTURES IN METALLURGY.

The Company have arranged for a COURSE of THREE LECTURES to be delivered at the ROYAL SCHOOL of MINES, Prince Consort-road, South Kensington, at 5.30 p.m. on TUESDAYS, the 15th, 22nd, and 29th NOVEMBER, 1932, by Professor Sir HAROLD CARPENTER, F.R.S., M.A., Ph.D., on

"THE METALLOGRAPHY OF SOME NATIVE METALS."

Admission Free, without Ticket. 9099

The Institution of Chemical Engineers.

EXAMINATION, 1933.

Application forms (returnable 19th December, 1932) and particulars of the Associate-Membership Examination for 1933, together with the Memorandum on "The Training of a Chemical Engineer," may be obtained from the HON. REGISTRAR, Institution of Chemical Engineers, Abbey House, Westminster, London, S.W.1. 9136

Borough of Bangor.

COUNTY DOWN, IRELAND.

MAIN DRAINAGE.

CONTRACT NO. 6.

TO BRITISH MANUFACTURERS OF NON-CHOKEABLE CENTRIFUGAL PUMPING PLANT.

The Council of the Borough of Bangor is prepared to receive TENDERS for the SUPPLY and ERECTION of THREE SETS of ELECTRICALLY DRIVEN HORIZONTAL NON-CHOKEABLE PUMPS, to be installed at the Luke's Point Pumping Station. Each pump shall be capable of pumping crude, roughly screened sewage at the minimum rate of 880 gallons per minute and against a total head of 72ft. The pumps shall be electrically driven by means of auto-asynchronous motors and be controlled by float-operated automatic starting apparatus.

The work included in the contract covers all cable and wiring work with piping and valves, &c., inside the pump house in accordance with the drawing, general conditions and specification prepared by the Engineers, Messrs. John Taylor and Sons, Caxton House, Westminster, S.W.1.

The general conditions, specification, and a copy of the drawing may be obtained by the manufacturer from the offices of the Engineers upon payment of £5 (cheque only), which will be returned upon receipt of a bona fide Tender.

The works are being expedited for the relief of the unemployed, and the contract will be subject to special conditions laid down by the Ministry of Labour, Northern Ireland, for Public Utility Schemes.

Tenders, in sealed envelopes, endorsed "Tender for Sewage Pumping Plant, Contract No. 6," must be delivered at my office at the Town Hall, Bangor, County Down, Ireland, on or before Twelve Noon on Monday, the 12th day of December, 1932.

The Council does not bind itself to accept the lowest or any Tender.

By Order,
(Sgd.) R. M. MOORE,
Town Clerk.

Town Hall, Bangor, Co. Down. 9138

Borough of Swidon.

WATERWORKS.

LATTON WATER SCHEME—CONTRACT NO. 6.

BLUNSDON RESERVOIR.

The Corporation invite from experienced contractors TENDERS for the CONSTRUCTION of a CONCRETE RESERVOIR of about 1½ million gallons capacity, with Auxiliary Works.

The general conditions of contract, specification, bill of quantities and form of Tender, prepared by the Engineer, Dr. Herbert Lapworth, M. Inst. C.E., 25, Victoria-street, Westminster, S.W.1, may be obtained from the undersigned on application on or after Monday, the 14th November, 1932, on payment of a cheque of £5 made payable to the Swindon Corporation, which will be returned on receipt of a bona fide Tender.

Facilities for seeing the drawings and inspecting the site can be obtained on application from Mr. J. B. L. Thompson, M.C., A.M. Inst. C.E., Borough Surveyor and Water Engineer, 34, Regent-circus, Swindon.

Sealed Tenders, endorsed "Tender for Latton Water Scheme, Contract No. 6," to be sent to the undersigned and received not later than 10 a.m. on Monday, the 5th of December, 1932.

The general conditions of contract will contain special conditions laid down by the Unemployment Grants Committee.

The Corporation do not bind themselves to accept the lowest or any Tender.

W. H. BENTLEY,
Town Clerk.

Town Hall, Swindon,
5th November, 1932. 9141

The Madras and Southern Mahratta Railway Company, Limited,

invite TENDERS for :—

400 TONS (APPROX.) STEEL MATERIAL (comprising : M.S. Plats, Rounds, Angles, Squares, &c., approx. 351 tons, and M.S. Plates and Sheets approx. 58 tons).

Tenders are due in on Tuesday, 6th December, 1932, by 2.00 p.m.

Tender forms are obtainable at address below, fee ONE GUINEA each, WHICH WILL NOT BE RETURNED.

The Directors do not bind themselves to accept the lowest or any Tender.

Company's Offices :—
25, Buckingham Palace-road,
Westminster, S.W.1. 9154

The Engineer

PRINCIPAL CONTENTS OF THIS ISSUE.
ARRANGED FOR CARD INDEXING.

Precision Grinding Machines No. VIII. (P. 475)
THE ENGINEER, 11 - 11 - 32.

Dynamic Effects in Railway Bridges. (P. 492)
(C. E. INGLIS.) THE ENGINEER, 11 - 11 - 32.

Salvage of Submarine M 2. (P. 475)
(D. J. MUNRO.) THE ENGINEER, 11 - 11 - 32.

Articulated Locomotive for Algeria. (P. 480)
THE ENGINEER, 11 - 11 - 32.

Industrial Economics in America. (P. 476)
(W. G. L. CASS.) THE ENGINEER, 11 - 11 - 32.

French Liner Normandie. (P. 477)
THE ENGINEER, 11 - 11 - 32.

Atomic Projectiles and their Applications. (P. 486)
(LORD RUTHERFORD.) THE ENGINEER, 11 - 11 - 32.

Marine Motor Show. (P. 477)
THE ENGINEER, 11 - 11 - 32.

Visit to the English Electric Co.'s Works. (P. 487)
THE ENGINEER, 11 - 11 - 32.

INDEX TO ADVERTISEMENTS, PAGE 53.

PUBLIC NOTICES.

County Borough of Belfast.

TO CONTRACTORS.

CENTRIFUGAL PUMP FOR NO. 1. PUMPING STATION.

TENDERS are INVITED for the SUPPLY and ERECTION of ONE ELECTRICALLY DRIVEN CENTRIFUGAL PUMP, to deliver 12,000 gallons per minute with Switchgear, Priming Pump, &c.

Copies of the form of Tender, specification, general conditions and drawings may be obtained at the City Surveyor's Department (Engineering Section), Room 94, City Hall, Belfast.

Sealed Tenders, on the form provided, enclosed in the official envelope, endorsed "Tender for Centrifugal Pump" and marked with the name and address of the firm tendering, to be delivered at the office of the undersigned not later than Monday, 5th December, 1932.

An official receipt must be obtained for every Tender delivered by hand. Tenders sent by post should be registered.

The lowest or any Tender will not necessarily be accepted.

R. MEYER,
Town Clerk.

9139

London County Council.

TENDERS are INVITED for SUPPLY and DELIVERY in London of TRAMWAY RAILS, &c., in 1933-34 :—

(1) SECTION A.—About 2935 Tons of Track Rails and Guard Rails.
SECTION B.—About 45 Tons of Fishbolts and Nuts.

(2) About 800 Tons of Conductor Tee Rails.

(Tenders will be considered for separate sections.)

The specifications, forms of Tender, drawings, &c., obtainable from General Manager of Tramways, 23, Belvedere-road, S.E.1, upon payment of £2 in each case, i.e., (1) and (2) by cheque or draft to the order of the Council. This amount returnable only if tenders shall have sent in a bona fide Tender and shall not have withdrawn same. Full particulars of the work obtainable on personal application, and contract documents may be inspected before payment of fee. Correspondence and remittances by post should be addressed to the GENERAL MANAGER of TRAMWAYS, 23, Belvedere-road, S.E.1, or personal application may be made to Room 222 at above address in respect of item (1) (Section A and B), and to Room 202 in respect of item (2).

Contractors will be bound to observe provisions of fair wages clause, the terms of which are set out fully in instructions for Tender and forms of contract and in "The London County Council Gazette."

No Tender received by Clerk of the Council at the County Hall, Westminster Bridge, S.E.1, after 4 p.m. on Monday, 28th November, 1932, will be considered.

The Council does not bind itself to accept lowest or any Tender. 9145

PUBLIC NOTICES.

Borough of Deal.

SEWAGE PUMPING STATION.

CHIEF SHIFT ENGINEER.

The Corporation of the Borough of Deal invite APPLICATIONS for the above APPOINTMENT from persons having experience with Diesel Oil Engines, Gas Engines, Centrifugal and Plunger Pumps, together with experience of Turning and Fitting.

The appointment will be a whole-time one, at the wage of £3 5s. per week less a temporary economy reduction. A house adjoining the Sewage Pumping Station will be provided rent and rates free, but without gas or coals.

Particulars of duties, &c., can be had on application to the undersigned.

Applications, in envelopes endorsed "Sewage Station Shift Engineer," giving full particulars of experience, accompanied by copies of three recent testimonials, to be sent to the undersigned not later than Friday, 18th November, 1932.

T. C. GOLDER,
Borough Engineer and Surveyor.

Municipal Offices,
Queen-street, Deal,
5th November, 1932. 9134

County Borough of Brighton.

WATERWORKS DEPARTMENT.

APPOINTMENT OF SECOND ENGINEERING ASSISTANT.

APPLICATIONS are INVITED for the APPOINTMENT of SECOND ENGINEERING ASSISTANT in the above Department, at a commencing salary of Five Pounds per week (less temporary deduction of 2s. 1d.).

Candidates, whose age should not exceed 35 years, must be well educated and have had previous experience in a Waterworks Engineer's office. They should be good Surveyors and Levellers, neat and expeditious Draughtsmen, and possess a sound knowledge of Building Construction, Service Reservoir Design, and Pipework. Other things being equal, preference will be given to candidates who have passed Sections A and B of the Associate Membership Examinations of the Institution of Civil Engineers.

Applications, stating age, qualifications and experience, accompanied by copies of not more than three recent testimonials, and endorsed "Second Engineering Assistant," should be addressed to me and delivered at my office not later than Wednesday, the 16th November, 1932.

A. B. CATHCART,
Waterworks Engineer.

12, Bond-street,
Brighton,
4th November, 1932 9121

PUBLIC NOTICES.

City of Norwich.

FOR SALE, ONE SIX-TON and TWO FIVE-TON YORKSHIRE STEAM WAGONS, in good working condition. Can be inspected at Westwick Depot, Westwick-street, Norwich, any weekday (except Saturday) between 9 a.m. and 5 p.m. by arrangement. Offers to be sent to the CITY ENGINEER, Guildhall, Norwich, not later than 26th November, 1932. 9135

Rochester Bridge in the County of Kent.

APPOINTMENT OF BRIDGE ENGINEER.

APPLICATIONS are INVITED for the POST of PART-TIME ENGINEER to the Rochester Bridge Wardens, at a salary of 150 Guineas per annum.

Further particulars can be obtained from the undersigned, to whom applications in writing (endorsed "Bridge Engineer"), stating experience and qualifications, together with not more than three recent testimonials, should be delivered not later than Tuesday, the 22nd November next.

By Order,
P. T. BAKER,
Bridge Clerk.

18, Star-hill, Rochester,
8th November, 1932. 9147

SITUATIONS OPEN.

COPIES OF TESTIMONIALS, NOT ORIGINALS, UNLESS SPECIFICALLY REQUESTED.

TO ADVERTISERS UNDER BOX NUMBERS IN THIS CLASSIFICATION.

For the benefit of applicants, the Proprietors are prepared to insert brief notices that vacancies are filled, upon receipt of notifications from the Advertisers. These notices (limited to one line) will be free of charge and co-operation is asked for.

CHIEF ENGINEER, EAST COAST.—The ADVERTISERS THANK all those who applied for the above post and beg to inform them that the VACANCY has now been FILLED. Owing to the numerous applications received a certain amount of delay in making the appointment was necessary.—8947, The Engineer Office. 8947 A

ENERGETIC REPRESENTATIVE WANTED for London and Southern District by first-class Firm of Overhead Electric Crane Makers. Remuneration by liberal commission. One having a live connection and capable of securing orders. State qualifications and when at liberty.—Address, 9149, The Engineer Office. 9149 A

GEAR CUTTING.—First-class Experienced MAN in a supervisory capacity, must be well up in latest methods of production and accustomed to all types of machines, REQUIRED by Large Motor Firm in the Midlands.—State age and experience by letter to Box 586, Dorland, 14, Regent-street, S.W.1. P2962 A

GENERAL MANAGER and First-class ORGANISER REQUIRED by Machine Tool Merchants and Importers. Must have thorough knowledge of the trade; practical engineering and perfect mastery of the German language. Only men with these qualifications need apply. State salary required, age, and previous experience.—Address, 9157, The Engineer Office. 9157 A

SALES ENGINEER, with Steam-raising Experience, REQUIRED by Firm of Water Treatment Specialists, to work in Midland area.—Write, Box 955, Sells Ltd., Fleet-street, E.C.4. 9146 A

DRAUGHTSMAN REQUIRED, Competent Estimate material and machining costs from drawings, experience in designing Rotary Exhausters, Compressors and Pumps. State age, experience, and wage required.—Address, 9144, The Engineer Office. 9144 A

SITUATIONS WANTED.

A.M.I.C.E., B.Sc., Commercial and Technical Engineering MANAGER, age 33, having specialised knowledge and many years' experience of oil engines, all types of pumping installations, electrical generating plant and refrigeration, REQUIRES POSITION next January as Engineering Manager of Waterworks or Industrial Undertaking.—Address, P2933, The Engineer Office. P2933 B

B.SC. (25), London University, Public School, and Clyde apprenticeship in steam, SEEKS APPOINTMENT, preferably in South. Accept small salary for good prospects.—Address, P2977, The Engineer Office. P2977 B

ENGINEER, Mechanical and Electrical, M.I. Mech. E., WISHES to REPRESENT High-class FIRM in London and Home Counties.—Address, P2978, The Engineer Office. P2978 B

ENGINEER (28), with Sound Theoretical and Practical training, DESIRES EMPLOYMENT with good prospects; willing to start at nominal salary.—Address, P2958, The Engineer Office. P2958 B

ENGINEER (30), B.Sc., A.M.I. Mech. E., at Present with consults. and inspects. organisation, DESIRES CHANGE of WORK. Loco. apprenticeship, wide exp. mechl., elec., and genl. engg. Excel. char., capable, hard-working and decisive. Make good tech. asst. or asst. works manager. £500 p.a.—Address, P2960, The Engineer Office. P2960 B

SITUATIONS WANTED (continued).

Page 2.
AUCTIONS, Page 54.
AGENCIES, Page 2.
MISCELLANEOUS, Page 54.
MACHINERY, &c., WANTED, Page 54.
FOR SALE, Pages 2 and 54.
EDUCATIONAL, Page 2.
PATENTS, Page 54.
BUSINESSES and PREMISES (For Sale, &c.), Page 54.
WORK WANTED, Page 54.

For Advertisement Rates see First Column Overleaf.

The Engineer

Annual Subscription Rates

(including postal charges).

Le prix de l'abonnement est accepté en livres sterling, ou dans la monnaie du pays d'origine au cours du change au moment de la commande.

Die Bezugsgebühren sind zahlbar in Pfundsterling oder in der Landeswährung des Bestellers, umgerechnet zum Kurse des Tages an dem die Bezahlung erfolgt.

Serán aceptados los abonos en moneda esterlina o su equivalente calculado en la moneda del páis de origen al cambio efectivo a la fecha de ponérse el pedido.

BRITISH ISLES ..	£3 5 0	
CANADA	£3 3 0	Thick Paper Ed.
	£2 18 6	Thin Paper Ed.
ABROAD .. .. (except Canada)	£3 7 6	Thick Paper Ed.
	£3 3 0	Thin Paper Ed.

AFRICA .. .. Central News Agency, All Branches.
CAPE TOWN: Wm. Dawson and Sons, Ltd., 29–31, Long-street (Box 489)
JOHANNESBURG: C. Juta and Co.

ARGENTINE .. BUENOS AIRES: Mitchell's Book Store, 576, Cangallo

AUSTRALIA .. Gordon and Gotch (Australasia), Ltd. All Branches
MELBOURNE: Robertson and Mullens, Elizabeth-street

BELGIUM .. BRUXELLES: E. Graddon, 186a Avenue Rogier, Schaerbeek
BRUXELLES: W. H. Smith and Son, 78–80, Rue du Marché-aux-Herbes

CANADA .. .. American News Company, Ltd. All Branches
MONTREAL: Gordon and Gotch, Ltd., 334, Notre Dame-street, W.
TORONTO: Wm. Dawson Subscription Service, Ltd., 70, King-street East
TORONTO: Gordon and Gotch, Ltd., 81, Queen-street West

CEYLON .. .. COLOMBO: Wijayartna and Co.

CHINA .. .. HONG KONG: Kelly and Walsh, Ltd.
SHANGHAI: Kelly and Walsh, Ltd.

DENMARK .. Teknisk Presse Bureau, Ourøgade 34, Copenhagen

EGYPT .. .. CAIRO: Express Book and Stationery Store, 9, Chareh Maghrabi

FINLAND .. HELSINGFORS: Akademiska Bokhandeln, Alexandersgatan, 7

FRANCE .. .. PARIS: Boyveau and Chevillet, Rue de la Banque, 22
PARIS: Librarie Berger-Leverault, 229, Bld. St. Germain
PARIS: Brentano's, 37, Av. de l'Opera
PARIS: Dunod, 92, Rue Bonaparte
PARIS: W. H. Smith and Son, 248, Rue de Rivoli

GERMANY .. BERLIN - LICHTERFELDE - WEST: H. Hermanns, Dahlemer Strasse, 64 A
LEIPZIG: K. W. Hiersemann, Konigstrasse 29

HOLLAND .. ROTTERDAM: Hector's Boekhandel, Noordblaak 59
ROTTERDAM: Techn. Boekhandel, "Plan C," Gelderschestraat 4

INDIA .. .. BOMBAY: Thacker and Co., Ltd.
CALCUTTA: Thacker, Spink and Co.

ITALY .. .. MILAN: Ulrico Hœpli
ROME: Maglioni and Strini, 307, Corso
ROME: Fratelli Treves, Corso Umberto 1, 174
ROME: Fratelli Bocca
TURIN: Rosenberg and Sellier, v. Maria Vittoria 18, and their Branches at Naples and Rome

JAPAN .. .. Maruzen Co. All Branches

JAMAICA .. .. KINGSTON: Educational Supply Co.

NEW ZEALAND AUCKLAND: Whitcombe and Tombs, Ltd.
Gordon & Gotch, Ltd. All Branches
NAPIER: J. Wilson Craig and Co.

RUSSIA .. .. LENINGRAD: Meshdunarodnaja Kniga, Prospect Volodiarsky, 53A
MOSCOW: Kuznetski Most 18.

STRAITS SETTLEMENTS—SINGAPORE: Kelly and Walsh, Ltd.

SWEDEN .. .. STOCKHOLM: A/B Wennergrens Journal-expedition, Stockholm 1
STOCKHOLM: A/B C. E. Fritzes Kungl., Hofbokhandel, Fredsgatan, 2

SWITZERLAND ZURICH: Rosa Leibowics, 4, Ankerstr.

UNITED STATES OF AMERICA International News Co., 131, Varick-street, New York, N.Y., and all Branches

Entered as second-class matter at the Post Office, New York, N.Y., December 12th, 1896, under the Act of March 3rd, 1879 (Section 397, P.L. & R.).

*** READING CASES, *to hold two copies of* THE ENGINEER, *cloth sides and leather backs, can now be supplied at 4s. 9d. each, 5s. 3d. post free.*

"THE METALLURGIST."

This Supplement, which deals with the Science and Practice of Metallurgy, both ferrous and non ferrous, is published free with the last issue of THE ENGINEER in each calendar month.

ADVERTISEMENTS.

The charge for Classified Advertisements is 1/- per line up to one inch—minimum charge 4/-; those occupying one inch or more at the rate of 12/- per inch. Orders must be accompanied by a remittance. The rates for Displayed Advertisements will be forwarded on application. Classified Advertisements cannot be inserted unless delivered before TWO o'clock on Wednesday afternoon.

Letters relating to the Advertisement and the Publishing Department of the Paper are to be addressed to the Publisher, all other letters are to be addressed to the Editor of THE ENGINEER.

THE ENGINEER DIRECTORY.

This Directory, which is published annually in the interests of advertisers in THE ENGINEER, may be obtained free of charge on application to the Publisher.

Postal Address, 26, Essex-street, Strand, London, W.C. 2. Telegr. Address, "Engineer Newspaper, Estrand, London." Tel., Central 6565 (8 lines).

PUBLISHED BY PITMAN'S

POWER ECONOMY IN THE FACTORY

By J. C. TODMAN, F.C.W.A.

A detailed analysis of the organisation and running of the modern workshop and factory from the economic and technical viewpoints. It is a manual of useful practical information which enables faults to be quickly detected and remedied, and also assists in the selection of economical and suitable machinery. Practical and direct, every responsible engineer and executive should have a copy.

224 pp. **7/6 net** Illustrated.

Write for detailed prospectus, post free on request.

SIR ISAAC PITMAN & SONS, LTD., PARKER ST., KINGSWAY, LONDON, W.C. 2

POWER-TRANSMISSION EQUIPMENT

We supply Power-Transmission Equipment for every conceivable purpose and to all specifications. *SPECIALITIES:* **Machine Cut and Machine Moulded Gears, Patent Spread-armed Belt Pulleys.**

We solicit your enquiries.

DOUGLAS FRASER & SONS, LTD.

WESTBURN FOUNDRY, ARBROATH, SCOTLAND

LONDON OFFICE: 62-63, MARK LANE, E.C.3. TELEPHONE: ROYAL 3515

SITUATIONS WANTED (continued)

CIVIL ENGINEER DESIGNER (36), A.M.I.C.E., DESIRES POSITION. Many years D.O. and works. Wide experience, reinforced concrete and all classes of civil engineering works. Moderate salary.—Address, P2965, The Engineer Office. P2965 B

ENGINEER-DRAUGHTSMAN, Experienced Tools, jigs, dies, special machinery for mass production; plant lay-out; inventive; twenty years U.S.A., Canadian; automobile, rubber (tyres, tubes), speedometer plants; age 39.—Address, P2976, The Engineer Office. P2976 B

ENGINEER (48), A.M.I.E.E., Extensive Experience hydro-electric development, heavy constructional work, including aerial ropeway design and operation Vickers, Ltd., apprenticeship) DESIRES POSITION of TRUST, home or abroad. Held position abroad, chief engineer, with organisation and administrative responsibilities, from which retired after 20 years' service, due to closing down of works. Highest references; moderate salary.—Address, P2957, The Engineer Office. P2957 B

ELECTRICAL ENGINEER to Large Iron and Steel Works in the North is DESIROUS of OBTAINING an ADVISORY or MANAGERIAL POSITION with Large Firm or Undertaking.

Advertiser is of exceptional organising ability and would not be adverse to joining consulting engineers or other similar governing bodies.

First-class references will be supplied.

Address, P2672, The Engineer Office. P2672 B

EXPERIENCED OIL ENGINE SALESMAN, Technical and practical, with up-to-date knowledge of prices and clients' requirements, valuable connection in the Midlands.—Address, P2954, The Engineer Office. P2954 B

MECHANICAL ENGINEER (27), Structural, Maintenance, installation, internal combustion engines, locomotives, sales, thorough practical training and commercial experience, organising ability, bachelor, home or abroad.—Address, P2959, The Engineer Office. P2959 B

STRUCTURAL ENGINEER (28), B.Sc. Eng., recently holding position of trust with consulting engineer, Westminster, DESIRES RE-ENGAGEMENT.—Address, P2952, The Engineer Office. P2952 B

SUGAR FIRMS.—MECH. ENGINEER (27), Scotch, technical college trained, 4 years workshop, 2½ years D.O., 3 years' contract in India (fluent Hindustani), excellent references.—Address, P2970, The Engineer Office. P2970 B

YOUNG MAN, Nearly 20, Studying Civil Engineering, WANTS POSITION in Workshops or Office of Engineering Firm, anywhere, at small wage.—Address, P2671, The Engineer Office. P2671 B

DRAUGHTSMAN DESIGNER, Machines, Jigs—general. Mechanic, estimates, correspondence, typing, sales, useful all round. Moderate salary.—Address, P2953 The Engineer Office. P2953 B

DRAUGHTSMAN (26) SEEKS POSITION; 8 years' D.O. experience, steam engines and boilers. Accept structural work. Neat, quick, and adaptable.—Address, P2955, The Engineer Office. P2955 B

DRAUGHTSMAN, 20 Years' D.O. Experience in general engineering design, including inventions and experimental work, also drawing-office organisation, and now AVAILABLE for IMMEDIATE APPOINTMENT.—Address, P2969, The Engineer Office. P2969 B

AS FOREMAN or SUB-CONTRACTOR, Home or abroad. Energetic man, experienced all civil eng. works, hydro-electric, oilfields, concrete, steel, masonry, mining, blasting, &c., set out, level. Good organiser; 4 years Africa and S. America. Good refs.—McCLEAN, 6, Caroline-square, Margate. P2956 B

DIVER, with 20 Years' Experience Harbour Works, submarine pipe lines, &c., SEEKS POST, home or abroad. Just completed 12 years in the East.—Address, P2968, The Engineer Office. P2968 B

AGENCIES.

CONSULTING ENGINEERS of World-wide Reputation, good offices and competent staff in Glasgow, DESIRE to REPRESENT in Scotland an English Firm of standing with some good proposition. Representation must carry substantial remuneration, for which best possible and influential service would be given. References exchanged with principals only.—Address, "ALPHA," Wm. Porteous and Co., Advertising Agents, Glasgow. P2673 D

MECHANICAL ENGINEER, Good London Connection, available REPRESENT LIVE FIRM anxious increase sales.—Address, P2675, The Engineer Office. P2975 D

SALES ENGINEER, with Connection Amongst foundries and engineering works, Yorks., Lancs., Midlands and the South, REQUIRES good SELLING LINE to run in with present one. Ground covered with own car.—HALL, 99, Bedford-avenue, Barnet, Herts. P2961 D

AGENCIES.

OLD-ESTABLISHED BRITISH HOUSE, Replacing important German Works' and other Agencies, DESIRE REPRESENT in Lancashire, Yorkshire and Cheshire, commission basis, leading British Works with large outputs—Semis and Finished Steel, Heavy Steel Castings, and Forgings of largest dimensions.—Address, 9129, The Engineer Office. 9129 D

EDUCATIONAL.

CORRESPONDENCE COURSES

of Preparation for the EXAMINATIONS of the INST. OF CIVIL ENGINEERS, INST. OF MECHANICAL ENGRS., PRELIMINARIES, MATRICULATION, &c., ARE PERSONALLY CONDUCTED BY

Mr. TREVOR W. PHILLIPS,

B.Sc. (Honours), Assoc. M. Inst. C.E., A.M.I.Struct.E. M.R.S.I., F.R.S.A., Chartered Civil Engineer, &c.

Prospectus and full particulars on application to:—36, DALE STREET, LIVERPOOL.

LONDON OFFICE:—45, CHANCERY LANE, W.C.2.

A.M. Inst. C.E. EXAM., MAY, 1932.

FIRST PLACE.

Gained by T. I. G. B. Student.

Read his letter, which speaks for itself:—

"You will be pleased to hear that, at the recent examinations of The Institution of Civil Engineers, I obtained highest place in the Associate Membership Examination, Sections A and B, and have been awarded the "Bayliss Prize" of £15. I am, of course, extremely gratified by this result and hasten to thank you for your valuable help and guidance during my studies for this examination. I hope that my success will be crowned by receiving Associate Membership of your Institution, which has been of real service to me."

F.G.T. (Studentship No. 17472.)

The services of over 70 specialists, many of whom are recognised authorities in their respective spheres, have been utilised in the compilation of The T.I.G.B.'s Correspondence Courses. Write to-day for "The Engineer's Guide to Success"—140 pages—containing the widest selection of engineering courses in the world. The T.I.G.B. guarantees training until successful.

The Technological Institute of Great Britain,

76, Temple Bar House, London, E.C. 4.

(*Founded* 1917. 18,000 *Successes*)

FOR SALE.

BRISTOL.

DISMANTLING STOTHERT'S SHIPYARD AND ENGINEERING WORKS.

FOR IMMEDIATE SALE at Bargain Prices to ensure quick clearance.
Punching and Shearing Machines.
Angle and Rod Shears.
Plate Bending and Flattening Machines.
Hydraulic Plant.
Compressor Plant.
Large Planing Machine.
Large Face-plate Lathe.
Machine Tools and Equipment of Fitting Shop.
Contents of Stores, &c. &c.
JOSEPH PUGSLEY and SONS, Ltd., Lawrence Hill, Bristol. 9152 G

FOR SALE.
THREE 20ft. by 9ft CYLINDRICAL PETROL STORAGE TANKS.
10in. by 12in. VERTICAL THREE-THROW BELT-DRIVEN RAM PUMP, by Pearns, capacity 23,000 gallons per hour.
VERTICAL COMPOUND BOILER FEED PUMP, by Hall and Sons, 6½in. and 9½in. cylinders by 6½in. water end by 12in. stroke.
STANLEY ENGINEERING CO., Bath. Telephone 4294.

OFFERS REQUIRED for the Whole, or Part, of the MACHINERY, PLANT, &c., including 5 H.P. and 10 H.P. A.C. Motors, Shearing, Drilling and Cropping Machines, Presses, Shafting, &c., Loose Plant and Tools, now lying at Gifco Casement Works, Millmarsh-lane, Brimsdown, Middx.—Orders to view from BROMHEADS, The Valuers, 30/32, Ludgate-hill, London, E.C.4. 'Phones, Central 2536/4168. 9150 G

FOR SALE, THEODOLITES.
DRAWING INSTRUMENTS, SECOND-HAND.
CLARKSON'S, 338, High Holborn, W.C.
(Opposite Gray's Inn-road).

FOR SALE, LEVELS.
DRAWING INSTRUMENTS, SECOND-HAND.
CLARKSON'S, 338, High Holborn, W.C.
(Opposite Gray's Inn-road) Ex

HESSIAN, PACKING CANVAS, SACKING, SACKS, FIBRES. Any quantity supplied.—H. C. JOHNSON and CO., 58 Kinfauns-road, Goodmayes, Essex. P2909 G

FOR SALE.

JOHN HANDS' WORKS, BIRMINGHAM.

MACHINERY AND PLANT FOR SALE

Twenty Gap Bed and other LATHES. Well-known makers.

Seven Horizontal and Vertical BORING MACHINES. Dickinson, Bullard, etc.

Five RADIAL DRILLING MACHINES up to 6ft., by Swift, Archdale, Cincinatti-Bickford.

Butler PLANER, 14ft. by 6ft. by 6ft.

Herbert PLANER, 12ft. by 5ft. by 5ft.

Four SHAPING MACHINES, 15in. by 24in. stroke. Steptoe, Butler, Dickinson, etc.

SLOTTING MACHINES, HACK SAWS, MILLING MACHINES, POWER PRESSES, HYDRAULIC PLANT.

Write for detailed catalogue:

JOHN HANDS' CARDIGAN WORKS,

BELMONT ROW, BIRMINGHAM.

FOR SALE, 28ft. LANCASHIRE BOILER, "Yates and Thom," 150 lb. w.p., complete all fittings. Green's Patent FUEL ECONOMISER, complete with Electric Motor, Starter, Thermometers and Circulator used with above.—McKENZIE, 39, North-lane, Canterbury. P2967 G

IMPREGNATING and DRYING CHAMBER to Armatures, &c., by Geo. Scott, practically new chamber 15ft. long by 7ft. 6in. dia., with Condenser, Vacuum Pump and Compressor, Mixing Tank with about 700 gals. Insulating Varnish. Bargain price.
HARRY H. GARDAM and CO., Ltd., Stalines. 9131 G

WARD 6½in. CENTRE PLAIN CAPSTAN; 1⅝in. dia. hollow spindle; dia. of tool holes in capstan 1¼in.; cross slide with back and front toolposts; 3-step cone for 3in. belt. Price £34.

CARSON GEAR HOBBING MACHINE; for spur, spiral and worm gears; dia. of work admitted, 0in. to 6in.; max. face for spur gears 4½in.; work spindle No. 10 B. & S. taper; cutter spindle No. 6; H.P. required 2; crank shaft speed 250 r.p.m.; machine will cut 8 D.P. in C.I. spur wheels, or 10 D.P. spirals; fly-wheel mounted on cutter spindle; machine of patent type, ensuring rigidity and freedom from backlash. Price £45.

TWO LANDIS No. 1½ INTERNAL GRINDERS; max. swing 11½in. dia.; single-pulley gear box drive; headstock swivel graduated to an angle of 45 degrees; swivel table graduated to 20 degrees; to grind taper 4in. per foot. Price £70 each.

HENDEY 24in. STROKE SHAPING MACHINE; table 17in. by 12in. by 16in. deep, with 25in. longitudinal traverse; height admitted 17in.; 5in. power vertical feed, to tool-box; admit 3½in. bar through machine; friction clutch belt drive. Price £55.

CINCINNATI SEMI-AUTOMATIC FACE MILLING MACHINE; working surface of table 60in. by 11in.; table travel 32in.; vertical adjustment to head; fast and loose pulley drive through gear-box; rebuilt and guaranteed. Price £100.

BROWN & SHARPE No. 3 UNIVERSAL MILLING MACHINE; working surface of table 50in. by 11¼in.; automatic feeds; longitudinal 30in.; cross 10in.; vertical 19in.; 4-step cone drive for 3in. belt; 16 speeds; 20 feeds; dividing heads; rebuilt and guaranteed. Price £200.

NORTON 14in. by 72in. PLAIN GRINDER; admit 76in. between centres; size of standard wheel 20in. by 2in.; largest wheel that can be used 24in. by 4½in.; countershaft speed 550/560; H.P. required 10/15; with steadies and pump. Price £320.

GEO. COHEN, SONS & CO., LTD.,
4, SUNBEAM-ROAD, PARK ROYAL,
LONDON, N.W.10.
Nearest Station: North Acton (Central London Railway).

For continuation of For Sale Advertisements see page 54.

Spencer-Bonecourt Patent Waste Heat Boilers.

32, Farringdon Street, London, E.C.4.

Telephone Central 9803. Telegrams Compression, Birmingham. *Established 1900.*

Herbert W. Black. INSPECTING ENGINEER.

Swan Buildings, Edmund St. Birmingham. *Valuations and Arbitrations.*

WILSON BOILERMAKERS LTD., GLASGOW.

Makers of LANCASHIRE, CORNISH and ECONOMIC or DRYBACK BOILERS.

A Seven-Day Journal

Road and Rail.

A NUMBER of Associations, Conventions, and Conferences sent in to the Minister of Transport during the last week their observations on the report of the Salter Conference. Nearly all subjected the findings of that Conference to severe criticism. The Commercial Motor Users' Association submits that the relaxation of restrictions on the railways rather than the placing of additional burdens on road transport should have been recommended, and points out that any disabilities the railways suffer in competition with the road are caused by conditions governing the railways resulting in high charges and inelasticity in operating costs. The Association gives reasons why it cannot accept the figure of £60,000,000 per annum as a fair estimate of the total cost of road construction and maintenance in the future . . . While agreeing to the two principles set out in the report that the railways ask no more than that road transport should pay its fair share of the cost of the roads, and that road transport does not ask that it should pay less than its fair share, the London Chamber of Commerce considers that the proposed allocation of road costs throws upon one section of the users of the roads far too large a burden, and draws attention to the fact that with regard to the tax on petrol that fuel is not confined to transport on the road. It points out also that cheap transport is of fundamental importance to industry. Objections are made to a number of the minor recommendations included in the report, and in conclusion it is stated "It must be recognised that the haulage of goods by road constitutes a new and economic form of transport which has come to stay and of which traders should be entitled to have the fullest and freest use. It may be, therefore, that the railways will be placed on a proper competitive basis by a lessening of some of the existing legislative railway restrictions. . . . The Chamber disagrees with the imposition of any limitation of distance for the conveying of goods by road." . . . The Municipal Tramways and Transport Association declares that the Conference Report dealt with every kind of mechanically propelled vehicle, whereas the reference of the Conference clearly meant to apply only to rail and road transport of goods. The Conference, representing only 39·2 per cent. of the vast interests concerned, submitted taxation proposals affecting 60·8 per cent. absent interests.

Wireless Telephony for Shipping

WITH the completion of the work of equipping eight additional coastal wireless telephone stations entrusted to the Marconi International Marine Communication Company, Ltd., last May, eleven of these stations are now available to shipping. Beginning at Wick, in the North of Scotland, the stations extend down the East Coast, where there are "Cullercoats," the "Humber" and "North Foreland." Then comes "Niton," in the Isle of Wight, and "Land's End," with "Fishguard," "Seaforth" and "Portpatrick," on the West Coast; "Malin Head," in Northern Ireland, and "Valentia," in the Irish Free State. By means of this complete chain of low-power wireless telephone stations round the coasts of the United Kingdom and the Irish Free State, all ships voyaging in British waters and those on international voyages, while within 200 to 300 miles of the British coasts, can, if suitably equipped, communicate with any one of these coast stations at any time. The service area of each station has been arranged to overlap that of the next adjoining station on either side, so as to form a complete service area round the British Isles. Ships which do not normally carry wireless telegraph installations, and are under no obligation to do so under international regulations, are able to enjoy the benefits of wireless communication with land by means of simple and economical apparatus which can be operated by a member of the ship's ordinary *personnel*. The utility of the new service is said to have been shown very clearly by the steadily increasing number of ships, both trawlers and coasting vessels, that have been fitted with low-power ship installations by the Marconi Company.

British Steelwork Association.

AT the annual meeting of the British Steelwork Association, which was held in London on Friday, November 4th, Mr. Ben Walmsley, of Dorman Long and Co., Ltd., was elected President, and Mr. E. A. Wilson, of Archibald D. Dawnay and Sons, Ltd., Vice-president for the year 1932–1933. The Director, Mr. C. J. Kavanagh, reviewed the situation and emphasised the importance of the building industry as providing a large outlet for steel. The new steel code recently adopted by the London County Council, he said, offered great opportunities for cheap building, and would give a useful stimulus to revival if the existing difficulties connected with the full development of large sites were removed. In his speech, the retiring President, Mr. J. H. Humphryes, chairman of Braithwaite and Co., Engineers, Ltd., referred to the almost complete stoppage of all classes of work, both by public authorities and public utility companies, which, he said, had been overdone or not skilfully enough done. The work of public authorities and public utility companies, he continued, were identical in many fields, and the public mind needed to be disabused of the thought that all work undertaken by public authorities was non-productive expenditure. To-day public authorities undertook essential services, which, as in private hands, were revenue-producing, and a continuance of such constructional schemes should now be regarded with a more sympathetic eye. The sooner, he suggested, that the present disastrous breakaway from prices was checked by a judicious restarting along studied lines of necessary enterprises which set in motion key industries like the steel industry, the better it must be for employment in the country. The potential demand for steel was immense if it could only be made active again by a return of confidence.

London's Largest Telephone Exchange.

ON Tuesday, November 8th, the Postmaster-General, Sir Kingsley Wood, formally opened the new Mayfair telephone building in Farm-street, which has been specially designed by the Office of Works to accommodate four telephone exchanges. The site covers over 22,000 square feet, and there is a five-storey building. The Regent exchange was installed in it about a fortnight ago, the Mayfair exchange will be transferred to the building shortly, and will be followed in a few weeks by the Grosvenor and the Langham exchanges. The present capacity of the installation is as follows:—Mayfair, 8300 lines; Regent, 6160 lines; Grosvenor, 2500 lines; and Langham, 2680 lines. By adding another wing it will be possible to increase the capacity of the equipment to 30,000 lines. When the four exchanges above mentioned have been installed, the exchange will, we are informed, be the largest assembly of telephone exchange equipment in the British Empire. The work has been carried out by the Automatic Electric Company, Ltd., and its chairman, Sir Alexander Roger, presented the Postmaster-General with a pair of gold pliers, with which he cut off the wire of the last subscriber on the old Regent manual exchange and so effected a transfer to the automatic system.

New Shipbuilding Orders.

IT is with pleasure that we record in these columns several shipbuilding orders which have been placed within the last seven days or thereabouts. Reference is made elsewhere in this issue to the 200ft. passenger and cargo steamer for the Bombay Steam Navigation Company, Ltd., which is to be built at the Govan yard of Harland and Wolff, Ltd., and the machinery constructed at Belfast. She will have a twin-screw arrangement of triple-expansion engines, with one double-ended boiler designed to burn either coal or oil. On Thursday of last week it was announced that William Denny and Brothers, Ltd., of Dumbarton, had received an order from Williamson-Buchanan Steamers, Ltd., of Glasgow, for a new Clyde estuary passenger steamer, similar to the "King George V." and the "Queen Alexandra," of Turbine Steamers, Ltd., both of which ships were built at Dumbarton. The new vessel will be propelled by triple screws driven by high-pressure turbine machinery. The construction of the ship will be begun almost at once in order that she may be ready for service next summer. The firm has also received an order from the Southern Railway Company for another steamer. These orders, together with the recently placed naval orders, will bring about a welcome revival in the shipbuilding industry, both of the Clyde and the Tyne. On the South Coast, J. Samuel White and Co., Ltd., have received the order for the main propelling turbine machinery for the British sloops "Grimsby" and "Leith," now under construction at Devonport Dockyard, which will give useful employment to the firm's engineering shops.

The New Cunarders.

ON Monday last, in the House of Commons, the Prime Minister expressed his regret at the unauthorised statements regarding the building of the new Cunarders which had appeared in certain daily newspapers that morning, and had been followed by an official denial by the Cunard Company. A more positive contribution to this subject was made on Tuesday evening, November 8th, by Sir Robert Horne, when speaking in the House of Commons on the unemployment problem. Referring to the distress with which people were faced this winter, Sir Robert asked, Was there any form of aid by the State to industry carrying out its ordinary operations which would immediately increase employment without undue cost, or, indeed, any cost at all to the State? He recalled that twenty-five years ago the Government of the country lent the Cunard Steamship Company a large sum of money at 2¾ per cent. interest for a period of twenty years. With that loan the company built the "Lusitania" and the "Mauretania," which provided work for a large number of people. Every shilling of the loan was paid back and in addition the ships so kept up the prestige of Great Britain on the ocean that many orders came to our shipyards. He asked himself whether a similar operation was not possible at the present time. The Cunard Company, he continued, was anxious to build two ships, which would employ in their building and fitting several thousands of people. The Government might well consider itself legitimately safe by giving the help the company asked for. He believed it would not cost the State a penny. On the contrary, there would be a large saving in unemployment benefit by providing work for the men now idle. The question of the prestige of this country on the ocean was at stake. He suggested that a body of experts should be set up, like the Trade Facilities Committee, to see whether there were not similar instances in which the Government could give financial assistance without harm to anybody and greatly to the enlargement of the field of employment.

J. Samuel White and Co., Ltd.

THE announcement is made by J. Samuel White and Co., Ltd., shipbuilders and engineers, of East Cowes, Isle of Wight, and Southampton, that Engineer Vice-Admiral Sir George G. Goodwin, who, since the death of the late managing director, Mr. P. D. Ewing, has taken an active part in the control and management of the firm, has been appointed chairman of the company, and that Mr. A. T. Wall has been appointed managing director, and will take up his duties at Cowes early in the New Year. Mr. Wall, it may be recalled, received his early training at Devonport Dockyard, and later at the Royal College of Science, South Kensington, and the Royal Naval College at Greenwich. On leaving Greenwich, he was appointed assistant naval architect at the Thames Ironworks, and, after spending some further time as chief assistant to the chief draughtsman, he became head of the design department of Cammel Laird and Co., Ltd., of Birkenhead, in 1913, and four years later succeeded Mr. T. C. Tobin as naval architect. In 1920 he resigned this position to open practice as a consulting naval architect in Liverpool. During the past twelve years he has been closely associated with the design of the Cosulich liners "Saturnia" and "Vulcania," and with the steamers of the Canadian National Railways, and other vessels. In view of his extended legal practice, Mr. Wall recently opened an office in London. His great practical experience, combined with his wide technical knowledge and his many friends, eminently fit him for the work he is to undertake in which we wish him every success.

Road and Rail Overseas.

IN a paper of unusual interest read on Friday last before the Yorkshire Branch of the Institute of Transport, Mr. C. E. R. Sherrington, the secretary of the Railway Research Service, described the various measures which have been taken in countries overseas, in order to regulate competition between rail and road transport. In almost every country in the world, with the notable exceptions of India and of France, where the railways are continuing to incur enormous deficits, Governments, Mr. Sherrington pointed out, have found it necessary to restrict by various means the operation of road passenger services, and in many other cases they have applied very similar restrictive measures to the goods services. Nowhere, Mr. Sherrington continued, have the enacted legislative provisions been more severe than in certain parts of the British Empire, notably in South Africa, New Zealand, and especially in Australia, where in several states an attempt has been made to prohibit entirely competition between these two forms of transport. Alongside some of these measures, the recommendations of the Salter Conference appear mild, and the hope is expressed that, as Great Britain has been one of the last countries to see the necessity of avoiding destructive competition between road and rail transport, an effort should be made to deal with it as early as possible, bearing in mind the interests of the community as a whole.

The Comptroller-General of Patents.

THE Board of Trade announces the appointment of Mr. Mark Frank Lindley, LL.D., B.Sc., to be Comptroller-General of Patents, Designs and Trade Marks, in succession to Sir William Smith Jarratt, who, at the end of November, retires from office after thirty-eight years of public service. Sir William has been prominently associated with important developments in the protection of industrial property, and during his Comptrollership, since 1926, he has done much in the preparation and carrying through of the new Patents and Designs Act, which came into force at the beginning of this month. Dr. Lindley, his successor, has been one of the Assistant Comptrollers of the Patent Office since 1926. He is a Barrister-at-Law of the Middle Temple, and obtained a Certificate of Honour at the final Bar Examination. He also held the Barstow and King Edward VII. Research Scholarships. He is a Doctor of Laws of London University, and a Bachelor of Science with distinction in Physics. Dr. Lindley joined the Office on the examining staff of the patents side, and in 1926, when he was appointed Assistant Comptroller, was transferred to the Trade Marks Branch. He thus brings to his new office a wide knowledge of the two principal branches of Patent Office work.

LARGE CENTRELESS GRINDING MACHINES

LIDKOPINGS MEKANISKA VERKSTADS A/B, SWEDEN, ENGINEERS

(For description see opposite page.)

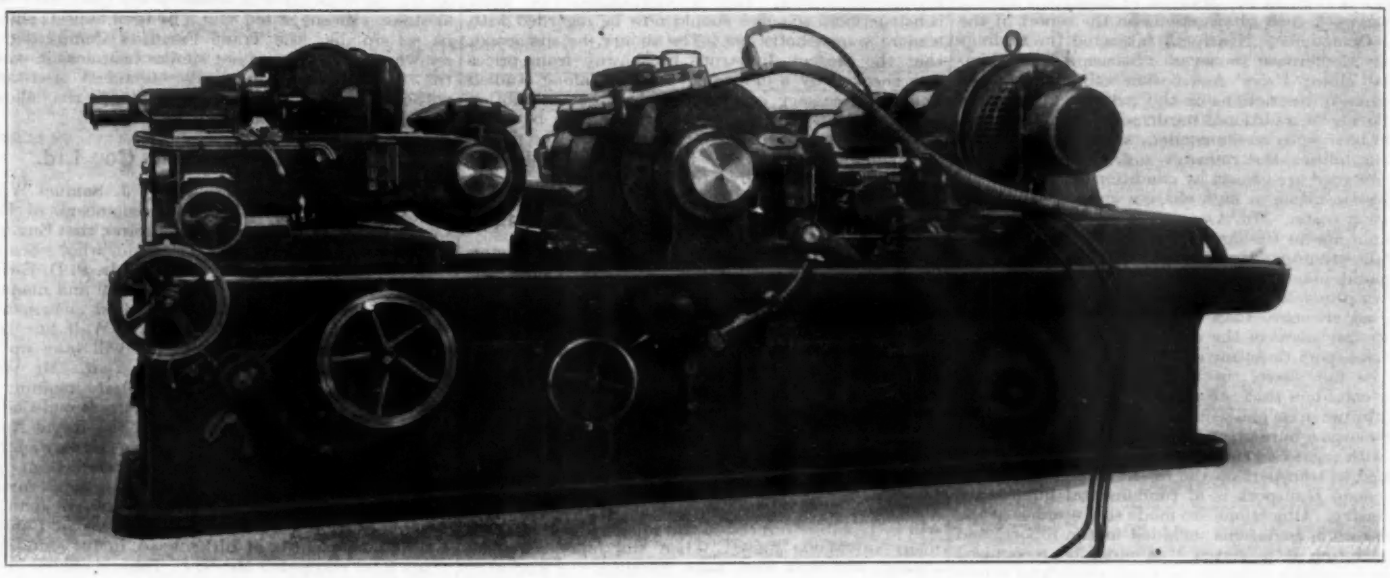


FIG. 45—OPERATING SIDE OF NO. 2 MACHINE

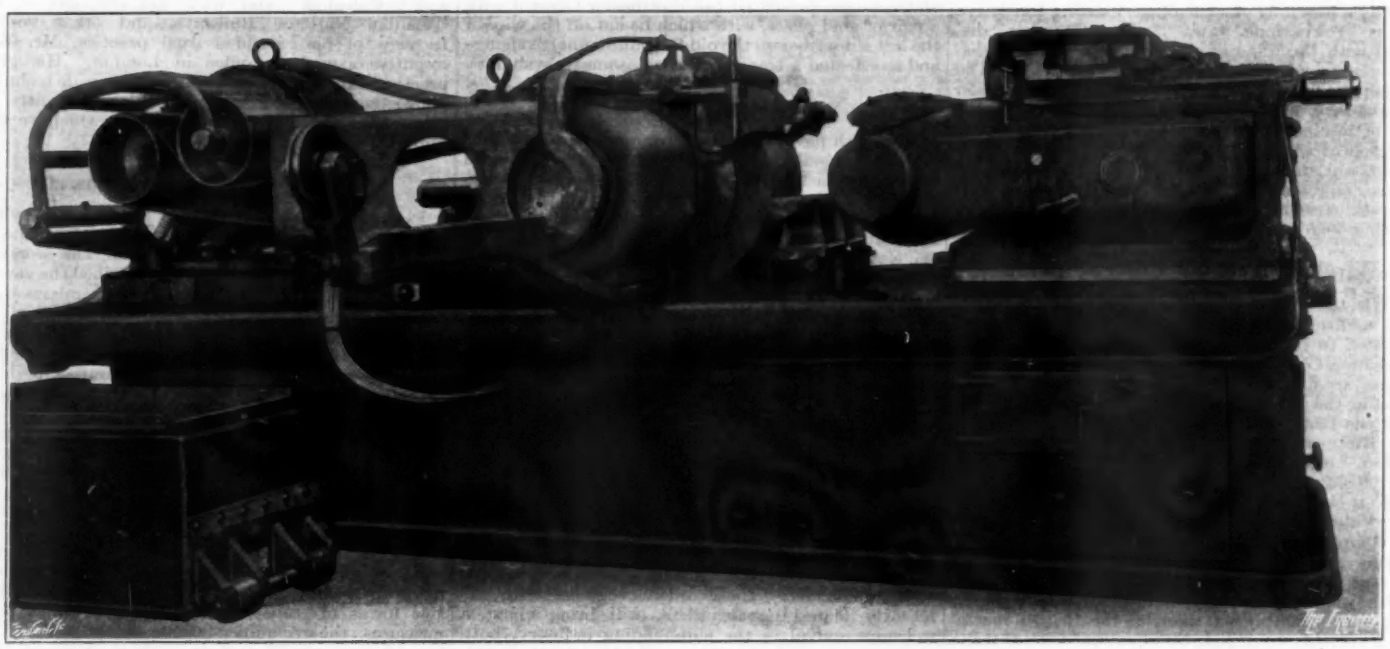


FIG. 46—EXIT SIDE OF NO. 2 MACHINE

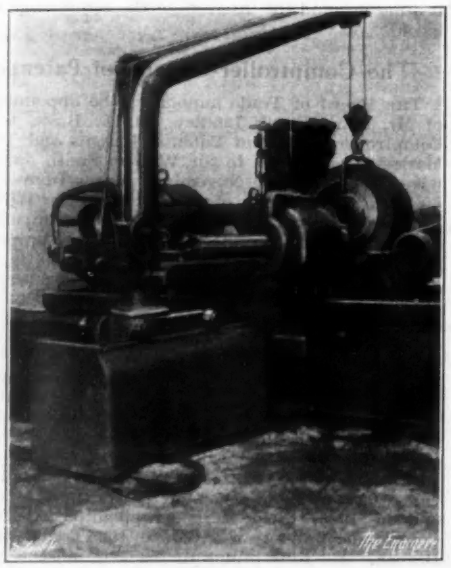


FIG. 47—CRANE REMOVING GRINDING WHEEL

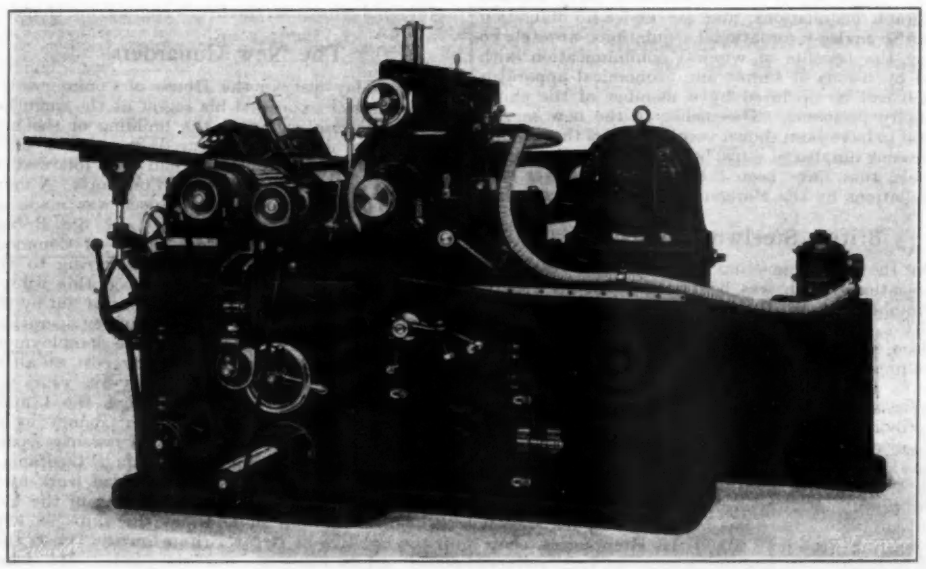


FIG. 48—OPERATING SIDE OF SMALLER MACHINE

Precision Grinding Machines.

No. VIII.*

CENTRELESS GRINDING MACHINES (*continued*).

THE centreless grinding machine, illustrated in Figs. 45 and 46, must be among the largest made at the present day. Constructed by Lidkopings Mekaniska Verkstads A/B, of Sweden, for which concern A. C. Wickman, Ltd., of Coventry, hold the agency in this country, the standard machine will grind pieces up to 10in. in diameter, while, equipped with smaller wheels, work 2in. larger can be ground. The grinding wheel, no less than 12½in. wide with a diameter of 25½in., running at 1030 r.p.m., absorbs up to 80 H.P., and is driven by a 12in. wide belt from a separate motor. A better conception of its

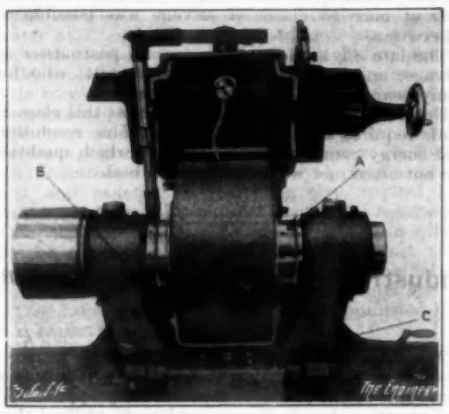


FIG. 49—GRINDING WHEEL SLIDE

size than mere figures can give is provided by the photograph reproduced in Fig. 47, showing the use of a specially designed crane for removing it. The illustration also shows the spindle withdrawn for changing the wheel, which is mounted between bearings, as will be explained later. Even the control wheel requires a driving motor of 7½ H.P. It has the same maximum width as the grinding wheel, with a diameter of 15¾in., and is rotated hydraulically at any speed between 4 and 60 r.p.m. Further small horse-power motors drive the diamond or mechanical wheel-dressing attachments.

This machine is a recent production of the firm. Its design is very similar, except, of course, in the size of the components, to that of the smaller—but still fairly large—machine illustrated in Fig. 48. The latter is capable of accommodating work up to 6½in. in diameter, has wheels 7½in. wide at the greatest, the grinder being 15¾in. and the controller 7½in. in diameter, and absorbs about 20 H.P. The grinding wheel rotates at 1700 r.p.m., and the control wheel at any of six speeds from 18 to 100 r.p.m. Both wheels are mounted upon slides, that supporting the grinder being fed inwards in the case of infeed grinding by the movement of a long lever equipped with a special "sizing" stop. Each of the two wheels has its separate trueing device, hand driven by a fine thread screw on the smaller, and power driven on the larger machine. They are mounted on the protective hoods over the wheels, and adjusted for depth of cut by means of graduated micrometer screws. To make the machine capable of undertaking taper grinding, the slide on which the trueing device of the grinding wheel is mounted can be set at a skew and the angle of taper which will be ground after dressing the wheel is indicated by a scale and pointer. Where special shapes require to be ground, suitable trueing devices can be supplied. Although in other respects the same as that for the grinder, the trueing device for the control wheel cannot be set at a skew, but may be swivelled in such a way that the wheel is correctly formed for making contact with the work across its whole face when its axis is set at an angle with the horizontal for through-feed grinding. A scale and pointer indicate the angle of inclination for which the wheel is properly dressed. The makers recommend that the diamonds for dressing the grinding wheel and control wheel of the smaller machine should be at least 2 carats and 1 carat in weight respectively, and it is pointed out that the greater the number of surfaces, the more economical the diamonds will prove in service. They also recommend the use of the widest possible wheels for through feed grinding, but regard it as preferable to use wheels not much wider than the length of the surface to be ground for the infeed method.

SPINDLE MOUNTINGS.

In the majority of grinding machines, centreless or ordinary, the wheels are mounted on an overhanging spindle. The arrangement has the advantage that the wheel may be rapidly and easily changed, and in most cases no difficulty is to be apprehended in making the bearings amply large enough to carry the load. Nevertheless, a two-bearing arrangement, although its design, if the wheel is to be easily changed, may be difficult, must certainly offer a better support for the wheel and probably becomes a necessity where very high powers are absorbed. Both these Lidkoping machines are designed to have wheels mounted between bearings, which are of such a form that changing the wheel takes little more time and gives hardly more trouble than it does with the conventional arrangement. The grinding wheel spindle is shown in Fig. 49. Sleeves forming part of the slide carry ball bearings within which the spindle rotates. To remove the wheel, the protective cover is raised, as shown, and the nut A loosened, with the result that the whole spindle may be withdrawn. Before, however, any attempt is made to remove it, the trough or lower guard B is raised by the rotation of a screw to support the wheel. This latter movement allows a new wheel to be delicately adjusted into position before the spindle is reinserted. There can also be seen in the illustration the lower end of the diamond-trueing device, the coolant piping, and at C the face upon which the work rest is bolted.

Like that of the grinding wheel, the spindle of the control wheel also runs in ball bearings, and may be withdrawn in the same manner if it is found necessary to change the wheel. The housing of this part may be swung so that the axis of the wheel lies up to 8 deg. from the horizontal for through-feed grinding. Besides the six speeds between 18 and 100 r.p.m. available for the control wheel of the smaller machine from the gear-box, an extra high speed—710 r.p.m.—drive through a silent chain for dressing the wheel may be engaged instantly by reversing a handle on the slide.

The face upon which the work rest is bolted has already been mentioned. The rest itself can be raised and lowered by the use of a hand wheel and locked securely in any position. Further dimensions and particulars of both machines are included in the table on this page.

GRINDING ATTACHMENTS.

Like all centreless grinders, a number of attachments are available for the Lidkoping machine by the use of which the grinding of a variety of parts is facilitated. As illustrated in Fig. 48, the smaller machine is equipped with a magazine loader for through-feed grinding suitable for cylindrical spindles, parallel shank twist drills and similar pieces of one diameter throughout. On the exit side the pieces are collected by a guide and made to roll down into a tray, whence the operator may remove them. Such attachments have the advantage that the operator need not be continually feeding the machine, and may make adjustments and check the sizes of the finished pieces without reducing the productive capacity.

	Small machine.	Large machine.
Minimum diameter that can be ground	1 mm. (0·04in.)	20 mm. (¾in.)
Maximum " " " "	180 mm. (7·125in.)	250 mm. (10in.)
Speed of grinding wheel	1700 r.p.m.	1030 r.p.m.
Diameter of the grinding wheel pulley	210 mm. (8¼in.)	—
Speed of regulating wheel :		
Number of speeds	7	Hydraulic
Minimum r.p.m. for grinding	18	4
Maximum " " "	100	60
Revolutions per minute when trueing the wheel	710	360
Grinding wheel :		
Diameter	400 mm. (15¾in.)	650 mm. (25½in.)
Maximum width	200 mm. (7¾in.)	325 mm. (12¾in.)
Inside diameter	225 mm. (8·858in.)	400 mm. (15¾in.)
Regulating wheel :		
Diameter	200 mm. (7¾in.)	400 mm. (15¾in.)
Maximum width	200 mm. (7¾in.)	325 mm. (12¾in.)
Inside diameter	80 mm. (3·150in.)	250 mm. (9·842 in.)
Bearings of the grinding wheel spindle :		
Diameter × length of the front bearing	78 mm. × 212 mm. (3in. × 8¼in.)	135 mm. × 375 mm. (5⅜in. × 14¾in.)
" " " rear "	65 mm. × 190 mm. (2½in. × 7½in.)	120 mm. × 330 mm. (4¾in. × 13in.)
Bearings of the regulating wheel spindle :		
Diameter × length of the front bearing	50 mm. × 100 mm. (2in. × 4in.)	105 mm. × 182 mm. (4⅛in. × 7⅛in.)
" " " rear "	40 mm. × 85 mm. (1⅝in. × 3⅜in.)	92 mm. × 170 mm. (3⅝in. × 6¾in.)
Width of the belt for grinding wheel	125 mm. (5in.)	300 mm. (12in.)
" " " regulating wheel	55 mm. (2¼in.)	—
Main drive motor	18–20 H.P.	70–80 H.P.
Recommended speed	About 1450 r.p.m.	—
Total power consumption of the machine	About 18–25 H.P.	—

Another illustration, Fig. 50, shows the larger machine fitted up for grinding bars up to 6in., or tubes up to 10in. in diameter in 20ft. lengths. When grinding such long and heavy work it is necessary to assist the control wheel to rotate and feed it. For this purpose a heavy iron table is placed on suitable foundations on each side of the machine. The top of each table carries a series of pairs of rollers driven by silent chain from a motor at the end furthest from the grinder. The rollers can be seen in the illustration, but no bar is passing through the machine. The driving motors of each table operate independently. To accommodate various diameters of bar the tops of the tables are vertically adjustable. At the end of each table nearest the machine the bar passes through a steady consisting of three rollers, and it is again supported at each end of the machine itself by similar steadies.

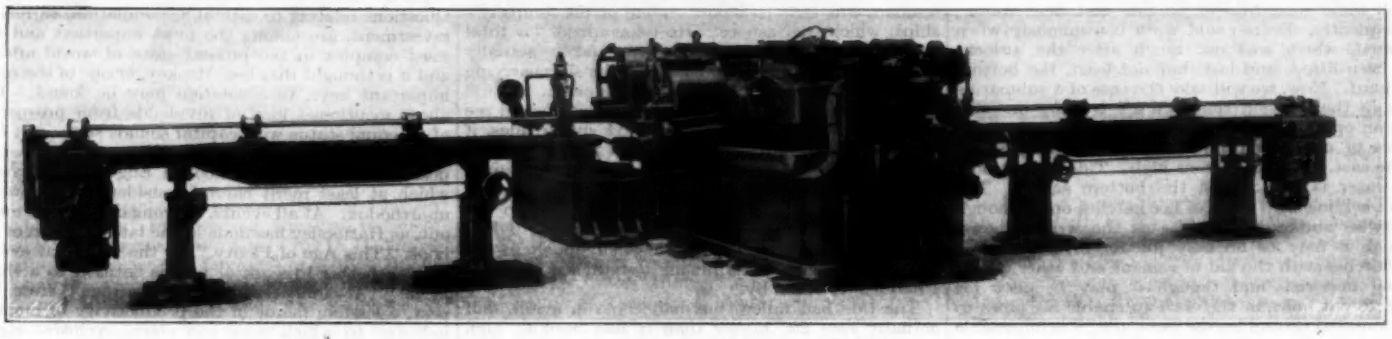


FIG. 50—NO. 2 MACHINE ARRANGED FOR GRINDING BARS

(To be continued.)

* No. VII. appeared November 4th.

Salvage of Submarine M 2.

By Captain D. J. MUNRO, C.M.G., R.N.

Now that the attempted salvage of submarine M 2 must again be put off for this season, or given up altogether, it may be just as well to go into the question of what has been done to recover this vessel, which sank some nine months ago When the craft was sunk the Admiralty evidently consulted with the firm of Messrs. Cox and Danks, shipbreakers, who had salved part of the German Fleet sunk in Scapa Flow, as to the salvage of this craft.

In the Press it was reported that they expected to raise her in a few days. When this time passed, it was reported that it might take a few weeks; then, again, it was reported that the salvage was delayed for a few days, but it was expected to have her in Portland in a few days, where all arrangements

had been made, such as providing coffins, &c., for the lost crew. Finally, the report was sent out that work would have to be delayed until better weather had set in in the spring.

The summer has come and passed, and as far as we know the salvage of this craft has not progressed. In fact, the final attempt made was a disastrous one, in that a great part of the work performed has now been undone, and there she lies, with nothing but the prospect of continuous gales for months to come.

The whole of this story does not say much for our advancement in the salvage of submarines for the last twenty-five years or so. One may criticise many of the endeavours made to raise this craft; but it is just as well to stick to fundamentals. The first attempt made was by compressed air.

Now, air has been employed extensively to salve ships for many years past.

The writer, over thirty years ago, visited the late Sir Frederic Young, marine salvor, when he was employed in getting a very large Atlantic cargo ship off the rocks at the Scilly Islands. The vessel was ashore fore and aft, and full of water up to the orlop deck. Captain Young, as he was then, hermetically sealed the 'tween deck, had this deck "tommed off" from the deck above, pumped air in, floated the ship off, and steamed her to Liverpool. The extent of damage to the ship's bottom will be realised when actually a motor car and numerous articles such as pianos were lifted up afterwards from the position in which she had been lying. Those articles had dropped through holes in her bottom. In this case the vessel could be sealed up above the water line.

The writer is also acquainted with numerous other cases where air has been employed successfully in the salvage of ships.

In the case of the German men-of-war sunk in Scapa Flow the operation was comparatively simple, as the ships were upside down, and there was practically no sealing up to be done as the bottoms were tight, or could be easily made so.

The great point in this operation was that by the aid of a tube and air lock the inside of the ships could be explored, and doors opened or holes cut in bulkheads, &c., to allow the air inside to equalise itself and so drive the water out by the deck openings fore and aft.

In the case of the "Hindenburg," the operation was a much more difficult one, as the ship was right side up with the deck just below water; consequently, it was a much harder job making her air-tight, owing to there being so many openings. Another point that crops up in connection with her was the very fact that she was right side up, consequently the question of stability came in when she was freed of a certain amount of water. This point did not arise with those ships floated bottom up. Over and above all other considerations, the ships were sunk in a land-locked harbour, in a position in which there was little or no tide and clear water; consequently, divers could work continuously when required, which was not much after the airlocks had been fitted, and last, but not least, the bottom was hard. Now, we will take the case of a submarine sunk in the position that "M 2" is lying in. She is in an open bay in the Channel, subject to the full effects of all gales from the west round by south to the east, and the sea runs high. Tides run strong, the water is murky and the bottom sandy. The vessel is lying with some of her hatches open, though otherwise undamaged, as far as the writer knows. Though it may be an easy job for divers to close the hatches with the aid of cement and other quick-drying material, and though it may be easy for them to cut holes in the craft to enable air pipes to be connected up and let the water out, it is impossible —owing to the confined space in a submarine—for a diver to enter and open doors and cut holes in bulkheads, &c., to ensure that the air inside is equalised, so enabling the water to be driven out from all compartments simultaneously, and thus float the craft.

I was once bothered by an amateur salvor who had rubber bags which he said he could place inside a sunken ship, pump air into them, and so float the craft. He could not inform me how he was, in the first place, going to get his bags into the ship, and, in the second, how he was going to fill them full of air, if there was no space, owing to cargo, &c., for them to expand into.

It is a simple operation to fill a hollow vessel lying at the bottom of the sea with air, and so float it; but it is a very different operation if the hollow vessel is full of bulkheads, &c., stopping the free circulation of the air, and you cannot get in.

It will be seen that the operation of lifting a large vessel lying bottom up, but to which you can secure a tube and airlock and get men into the craft, is a very different one to that in which the movement of air in the craft is left to chance.

If the submarine was lying in Scapa Flow, where the sunken German ships are, this method could have been successfully employed, as, in the absence of tides and swell, an airlock and tube could have been fitted, and so enable men to enter the submarine and make the necessary adjustments.

After various attempts to raise "M 2" by air alone camels were employed to assist, which could be sunk, secured to the craft, and then the air ejected, and so help to raise the craft.

They can support a weight of 80 tons each, and the four 320 tons, very far from 2000 tons, the dead-weight of the craft. Owing to the tides and swell, it is imperative that if those camels are to be employed for an operation of this description, and in the open sea, that no time should be lost between their being sunk, secured, and then filled with air, and the craft raised.

Those camels, lying for even one night sunk, will almost certainly cause the securing wires to be chafed and so destroyed. This is from experience of this class of work carried out by me some years ago.

If they had been employed in Scapa Flow, no swell and no tide, they would have given good results.

I have now been connected with salvage since 1887, or forty-five years ago, when I carried out temporary repairs to a ship of which I was in command, steamed her 100 miles, constructed a mud dock 150ft. long, 40ft. broad and 12ft. deep, got the ship in, cut out three plates in her bottom, put in new ones, and was back on my station in fourteen days. Since those days I have carried out many salvage operations, some successful and some not; but I have never yet carried out an operation in which I could be certain that a successful result would be achieved. One can only do one's utmost and hope for the best.

In 1909 I was in charge of salvage operations on "C 11," sunk on the East Coast after being in collision. In my opinion, all the information gained on the above operation, which I have fully described in my book "Scapa Flow: A Naval Retrospect," is applicable to the salvage of "M 2."

It is quite a mistaken idea when dealing with salvage that what is applicable to one set of circumstances can be applied to all other cases of salvage; and the system that was successful in Scapa Flow is probably the one *not* to adopt when dealing with a submarine sunk in the English Channel.

Given the direction that "M 2" is lying in being known, the lifting of the craft offers quite an easy problem, if suitable appliances are provided.

All lifting wires can be placed without the aid of divers; the wires can lie securely buoyed off until the weather and tides are favourable for lifting, and so prevent chafing.

The most successful salvor, other things being equal, is he who has had the most experience.

All seamen are to a certain extent salvors, but few are experts, as to become an expert one has to have plenty of practice, and this, fortunately, seamen do not get. Like the medical profession, the general practitioner diagnoses the disease and then, if necessary, calls in the specialist—and so with salving.

I have known of many cases in which the advice of amateurs has been taken in the salvage of ships, which has led to great expense and disappointment to all concerned. A case in my own knowledge was one where a marine superintendent, a very capable seaman, was sent to report on one of his company's ships, which was ashore. He telegraphed "a total loss." The ship was sold to a salvor, and she actually steamed up the Hooghley astern of the ship carrying the marine superintendent back to Calcutta.

I had a ship ashore once, and as far as I could see the case was hopeless until the next spring tides, if a gale from a certain direction did not spring up in the meantime, in which case she would almost certainly be a total loss. It was high water at noon, and after the tide had fallen a couple of feet I gave up the attempt, and returned in a tug to harbour. I had only been ashore a short time when, much to my surprise, I saw the vessel being towed clear by a tug I had left to stand by.

The tide had fallen, but had come in again, and actually rose 2ft. higher than it had been at high water, and the craft had floated free.

The rising of the second tide was due to a great gale hundreds of miles away.

So in salvage one never knows one's luck.

I swept for a sunken craft for two days without result, and on the second day had anchored to enable the men to get their dinners. We were going to return to harbour afterwards and give up the attempt to find the craft. I was leaning over the rail looking at the sea, when I saw a chip of wood float to the surface, with a piece of spun-yarn attached to it by a single turn. It did not float way as it should have done, as the tide was running. I thought this strange, and at slack water sent the diver down, and there was the ship I was seeking for, at the other end of the spun-yarn. As a race, we are good salvors, but the best, undoubtedly, are the Norwegians and Swedes. Their temperament enables them to remain for long periods awaiting a favourable opportunity and not wasting their energies in trying the impossible, as we, as a race, are inclined to do.

The best divers in the world come from Whitstable in Kent.

Diving under air pressure started there over 100 years ago, in connection with the oyster beds, and consequently a race of divers has sprung up in this town who go all over the world in pursuit of their calling.

The operation that the Italians are now carrying out to recover the gold from the "Egypt" is not in the ordinary line of salvage work. The so-called diver in this case is really a man enclosed in a steel box which takes the pressure of the water, and his job is to be lowered down and, looking through quartz portholes, communicate to those above what he sees. The salvage is actually done by blasting away the sides and decks of the ship in the neighbourhood of the strong room, and when the bullion is exposed a grab is lowered and the contents grabbed up. If the "Egypt" were lying in muddy water on a sandbank, the above mode of operation would be impossible.

It is not known what the attempted salvage of "M 2" has cost up to date. Some months ago it was told to the House of Commons that £26,000 had been spent. A small well-organised salvage department would be an extremely useful asset to the nation, so that, in future, attempts to salve national property would be undertaken by an expert in this line of business, who would be up to all the latest principles employed, and would be able at once to decide if salvage was possible or otherwise.

The late Sir Frederic Young was a pastmaster at salvage, and so was the late Mr. Armitt, who for many years made Leith his headquarters.

Great salvors are born, not made; as this class of work requires skill, courage, indomitable resolution and energy combined with patience, which qualities are not often met with in one individual.

Industrial Economics in America.

By W. G. LINN CASS.

ALL kinds of suggestions are being made to meet the present crisis in American industry. It is true that some of the proposed remedies may appear wild and startling, but it is more and more realised that drastic changes in social and economic structure may have to be made, and the will to experiment must be fostered with imagination and courage. Quite possibly the true path will only be found after ceaseless trial and error, practical experiment, numerous mistakes, and many failures.

Among the ideas which appear to be gathering force is that of decentralised industry, with its corollary of self-sustained or nearly self-sustained communities. The mass production obsession is being questioned along with much else. Production economics have too long dominated the American industrial horizon, and far greater attention must now be concentrated on consumption, with an underlying philosophy or mentality rather different from that of the high-pressure dynamic salesman. The remarkable suggestion, indeed, is made that the great masses of the people must draw dividends from prosperity upon some basis of equality with capital accumulation, otherwise investments in productive capacity alone "will crash of their own weight." Questions relating to capital accumulation, turnover, investment, are among the most important and the most complex in the present state of world affairs, and it is thought that here the key, or one of the most important keys, to a solution may be found. The above-mentioned idea of dividends from prosperity of an equal status with capital sounds somewhat like the "dividends for all" and consumer credit proposals of the Douglas school in England—proposals which at least merit careful consideration, however unorthodox. At all events, a strong case can be made out, as Hattersley has done in the latest edition of his book "This Age of Plenty," for the view that everybody, whether in work or not, is entitled to a share in the "Accumulated Cultural Heritage" from the past, a leading factor in the productivity of modern industry to which none can claim exclusive right. These views have nothing in common with socialistic or communistic principles, for these and other suggestions in America are invariably accompanied by strong condemnation of Socialism in any form. The new economic thought, in fact, finds its strongest justification in that it aims to prevent the further spread of Communism.

On the subject of capital, it is further pointed out that business success in future must be measured rather by the welfare and prosperity of the workers than by money profits alone. Ford has already found that these two factors are closely related, but something more than the payment of high wages on the Ford principle is obviously intended, in order to maintain consumer purchasing power on a plane of equality with plant production machinery. The suggestions here are a little indefinite, but the main idea is to correlate consumption with production, and make the full reward of the worker, and therefore his total purchasing power, dependent not entirely on the whim of the employer, but be governed largely by methods or principles inherent in the social and economic system and controlled by the State. A more definite proposal is that greater attention be paid to the rapid turnover of existing capital than to the accumulation and investment of more capital, thus increasing the velocity of circulation. A fuller and clearer realisation is also needed of the distinction, with all its implications, between ultimate consumer demand and intermediate demand (for purposes of production). Examples of this latter are plant, machinery, and raw material, representing capital

expended on consumption. Again, on the subject of capital, there are all the possibilities of capital-ownership by employees to be considered, and the further possibility of a worker being a small capitalist of his own in his leisure hours, giving him supplementary independent employment.

It is a natural transition from this latter to the ideal of self-sustained or nearly self-sustained communities, though the establishment of outside or foreign trade need not necessarily be excluded. Here there is a reversion again to the suggestion of decentralised industry with greater variety or diversification for the worker. Why not endeavour to enlarge and make the most of the markets at your very doors, instead of having your eyes eternally in the ends of the earth, and so save the vast economic waste of transport and attain also other important advantages? It is just here probably that the greatest opportunities for reducing costs will be found, paradoxical as it may seem to those enveloped in mass production ideas; and at the same time there is the greater likelihood of being able to correlate production with consumption. Consumer-purchasing power would probably be augmented, and as desires and needs increase in the community they are satisfied by an increase in local productive facilities, and both production and consumption grow together with increase in population and purchasing power. Furthermore, investors would very probably be much more strict and exacting in requiring that capital be written off at a more rapid rate, one of the results of which would be the gain by human labour in what may be called the "cost differential against the machine," or, in other words, the very remarkable result—the more remarkable in this machine age—that the human element would be less dominated by the machine element.

Another method suggested is the establishment of part-time supplementary industries—farm and garden work, handicrafts. In a leading American technical journal lately reference was made to the O. D. Young suggestion of the worker having a part-time smallholding, with a cow and pigs and poultry. This idea is not, of course, new, and was suggested in THE ENGINEER years ago by the present author. It has been found in practice in many ages and in many parts of the world, and has numerous and great possibilities of good, if properly worked.

As a practical illustration of many of the suggestions which have now been briefly noted, the case of New England is cited. It is pointed out that this part of the United States has suffered much less from the general depression than other states, and this is attributed largely to the foresight and enterprise of the New England Industrial Council, and to its marked success in reaching towards the ideal of a nearly self-sustained community, with greatly diversified industry, much of it on the small scale, and including all kinds of agricultural and allied occupations as well as manufacturing. But, as previously observed, there is no inherent necessity that such conditions should be inconsistent or incompatible with outside trade with other states and foreign countries.

Along some such lines as these perhaps we might evolve a system of social economy in which many different kinds and forms of industrial structure are possible. The human mind is not wedded to one form only, say, *e.g.*, large-scale industry working exclusively or nearly so for world markets. Some large-scale industry is doubtless necessary and desirable; but other types could be adopted as complementary thereto. Thus we should achieve greater elasticity and variety and adaptability in industry, and surely therefore less risk of unemployment. It is not necessary to carry machine production, mass production, to its optimum capacity; if some of it could be replaced by recreative handicraft, for instance, what would be the effect? Should we not gain on balance? Materialistic considerations are giving way to those of a higher order, and the aim of man's work is not wholly production of material wealth.

The French Liner Normandie.

On page 484 we reproduce three further photographs of the new 75,000-ton liner built for the Compagnie Générale Transatlantique by the Société des Chantier et Ateliers de Saint Nazaire (Penhoët), and launched on Saturday, October 29th. The description of the ship and her successful launch will be found in our last issue. The top photograph reproduced on page 484, taken from a position over the shops at St. Nazaire, shows the great length of the liner as she appeared on the stocks. It also makes clear the position and length of the side bilge keels, which are a feature of the hull design. The two lower engravings, a stern view on the stocks and a three-quarter bow view afloat, emphasise the special form of these parts of the ship. We referred in detail to the design of the bow, with its covered forecastle deck, in our article last week, but the stern view we now reproduce shows very clearly the large counter at the stern of the vessel, with the provision for the stern anchor.

A Plea for Co-operation.

Saturday, October 29th, was noteworthy not alone for the launch of the world's largest ship, but also for a speech made by Monsieur René Fould, the chairman of the Société des Chantier et Ateliers de Saint Nazaire (Penhoët), in which he advocated an international conference in order to regulate the world's shipbuilding. After recounting the events which led up to the ordering of a ship of the dimensions of the "Normandie," Monsieur Fould went on to speak of France's national aspirations, both as regards shipbuilding and shipowning. He thanked the principal officials of the builders and owners, mentioning Monsieur Romano, the chief engineer of the Compagnie Générale Transatlantique, and Monsieur Levy, the Penhoët director in Paris, and their respective staffs, which had loyally co-operated in the designing and building of the ship. He expressed regret at the shortage of work in the yard, now the "Normandie" was launched, there only remaining on the stocks the French cruiser "Emile Bertin," which will be launched early next spring.

The French merchant fleet, Monsieur Fould said, consisted of about 3,500,000 tons, but its high average age would probably force owners to accelerate the rate of replacement to 200,000 tons annually, with an annual value of 900 million francs, about half of which would be spent with the sub-contractors all over the country, as follows:—

	Million francs.
Iron and steel	150
Mechanical engineering	140
Electrical engineering	30
Chemicals	20
Wood	50
Sanitation	10
Decoration	20
Textiles	20
Navigation	4
Insurance	6

In 1930 and 1931, however, only 100,000 tons were built. Thus 225 million francs were lost to the industries of the country in the above proportions, in addition to the loss of 120 million francs in ship-yard wages and salaries, as well as 30 million francs which would have been paid in taxation.

Monsieur Fould pointed out that in shipbuilding there were no large international cartels or consortiums, such as existed in the steel, aluminium, chemical, textile, glass, paper, dyes, and other industries. In that connection he referred to the remarks he made just over a year ago when the Institution of Naval Architects visited the Penhoët yard in company with the Association Technique Maritime et Aeronautique. He had then explained that, in spite of all the rationalisation in other industries, shipbuilding had remained aloof from any effort having for its objective the improvement of its market, and no effort yet put forward offered, in his opinion, much hope of improvement in its international application.

While he felt that shipbuilding and shipowning in France were of little importance compared with those industries in Great Britain, it was difficult for French interests to take the initiative as regards international reorganisation. Accordingly, he suggested that the British shipbuilders should organise a conference to regulate world production, and so help to find a solution of a crisis from which all countries of the world were suffering.

Marine Motor Show.

ALTHOUGH the motor boat section of the International Motor Exhibition at Olympia, which closed on October 22nd, was not so large as that in previous years, there being only twenty-four stands compared with over forty last year, this year's Exhibition was made noteworthy by the advance shown in the design of high-speed airless-injection oil engines and their application both to fast cruisers and to commercial boats. There was also no lack of variety in the petrol and paraffin engines displayed, and among them we noted one or two novel designs for launches and racing craft. In what follows, a brief description of the more notable of the exhibits is given.

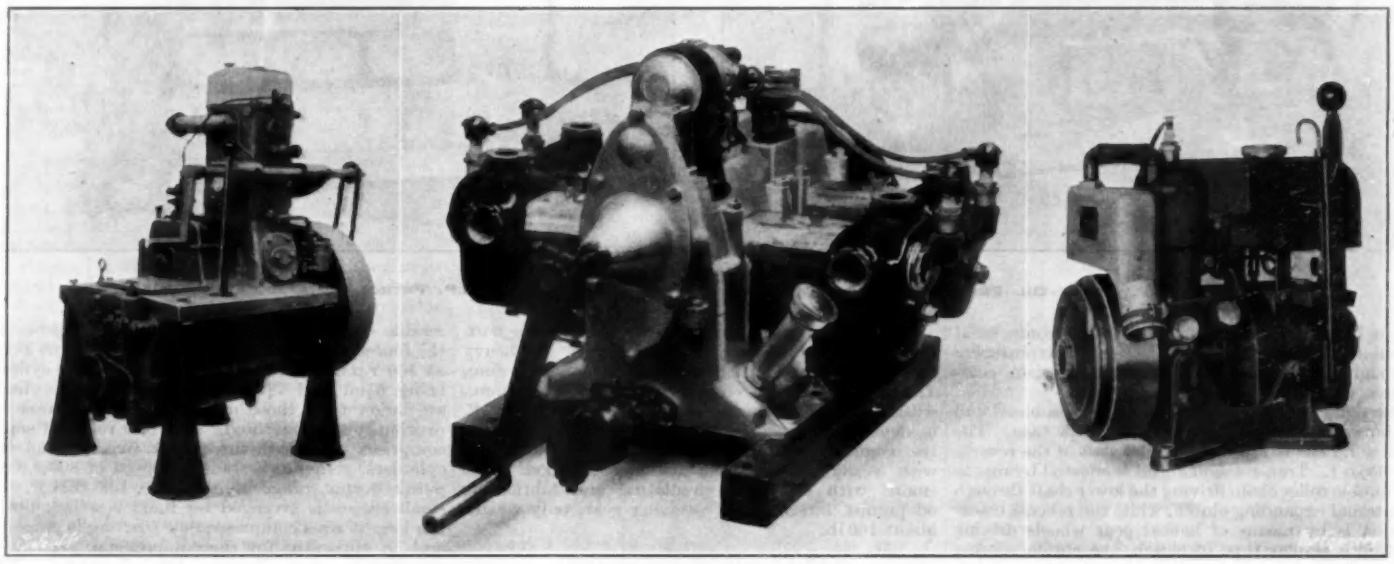


FIG. 1—9 H.P. ENGINE—THORNYCROFT

FIG. 2—30-37 H.P. ENGINE—COVENTRY-VICTOR

FIG. 3—2-5 H.P. ENGINE—BROOKE

John I. Thornycroft and Co., Ltd.

One of the largest displays was that arranged on the stand of John I. Thornycroft and Co., Ltd., of London, Reading, and Southampton. The principal exhibit was a family cabin cruiser *de luxe*, with a length of 30ft. and a beam of 8ft. 6in, fitted with a twin-screw arrangement of Thornycroft 14 B.H.P., four-cylinder engines, running at 1600 r.p.m., and coupled through reducing gears to propellers running at 800 r.p.m., giving the boat a speed of about 8½ miles per hour. Considerable ingenuity was shown in the neat arrangement of the cabin spaces.

While there was a comprehensive display of the firm's petrol and paraffin engines, ranging from the 7½ B.H.P. Handybilly twin-cylinder unit to the 140 B.H.P. six-cylinder Shark engine, the principal technical interest centred around the new Thornycroft compression ignition engine, two examples of which we illustrate in Figs. 1 and 4.

The single-cylinder engine, Fig. 1, has a bore of 4in., with a stroke of 6in., and is designed to develop 9 B.H.P. at 1200 r.p.m., the propeller speed being reduced to 760 r.p.m. by means of integral reducing and reversing gear.

In general, it may be said that the engine follows accepted designs. The fuel injector is mounted vertically in the cylinder head, and it sprays into a circular combustion chamber, which communicates with the cylinder by a single hole. The combustion chamber design has been found, we are informed, to

OIL AND PETROL ENGINES AT THE MARINE MOTOR SHOW

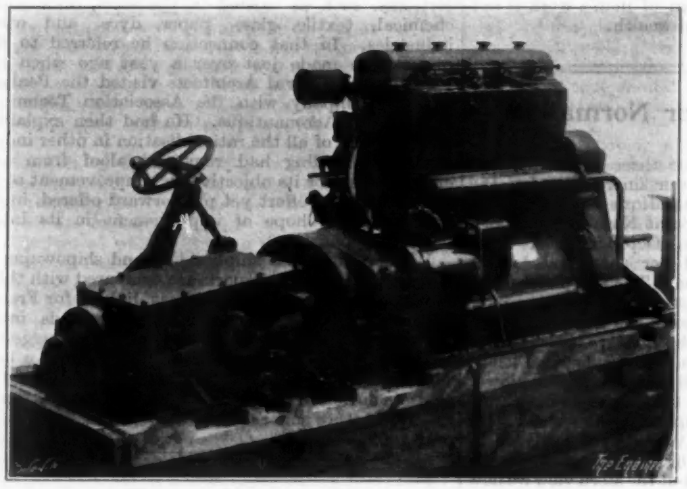


FIG. 4—62-85 H.P. HEAVY-OIL ENGINE—THORNYCROFT

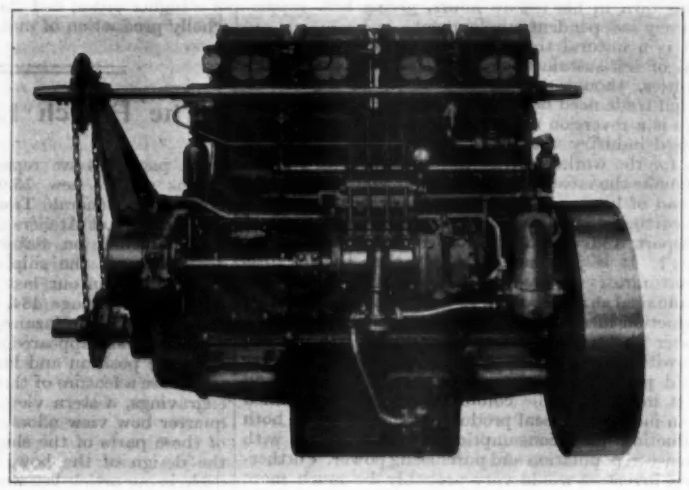


FIG. 5—66 H.P. HEAVY-OIL ENGINE—GARDNER

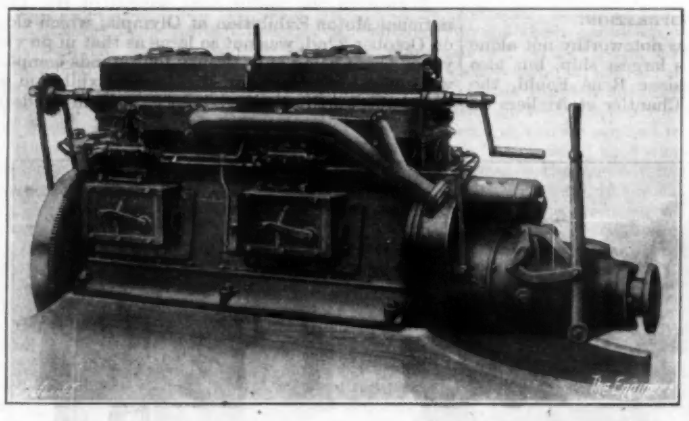


FIG. 6—36-60 H.P. HEAVY-OIL ENGINE—AILSA-CRAIG

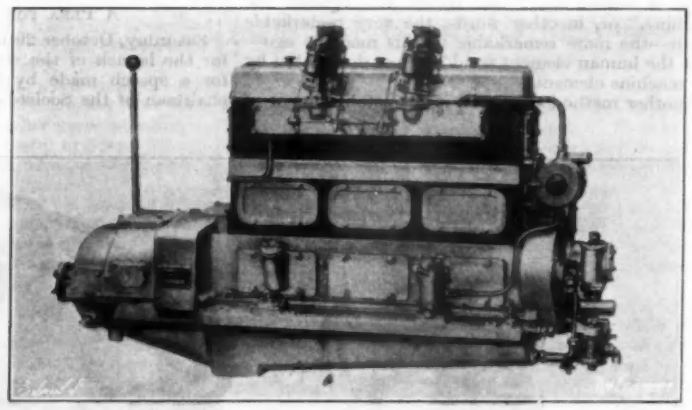


FIG. 7—100 H.P. PETROL-PARAFFIN ENGINE—PARSONS

give a high degree of turbulence to the compressed air charge at the time of injection, thus ensuring thorough mixing, and consequently complete combustion with a low fuel consumption.

The reducing and reversing gears are combined and are housed in an extension of the crank case. The reduction ratio is 1·58 to 1, whilst that of the reverse is 1·65 to 1. Transmission ahead is effected by means of a double roller chain driving the lower shaft through an internal expanding clutch, while the reverse transmission is by means of helical gear wheels driving through a similar type of clutch, the clutches being operated by means of a single lever.

The engine is fitted with forced lubrication supplied by a gear pump, and there is also a water circulating pump driven from the forward end of the cam shaft.

The four-cylinder model, illustrated in Fig. 4, has a bore of 4¾in., with a stroke of 6½in., and is designed to develop 62 to 85 B.H.P. at 1200 to 1600 r.p.m. The same general features in design as the single-cylinder unit have been adapted to the multi-cylinder designs. The crank shaft is carried in five white metalled bearings, which have a diameter of 3½in. Our illustration shows a standard Thornycroft reverse gear, and, when required, reducing gear, either of 2 : 1 or 3 : 1 ratio, can be supplied.

Considerable attention was attracted by the model of "Miss England III.," shown on the stand, and one of her solid steel two-bladed propellers.

THE COVENTRY VICTOR MOTOR COMPANY, LTD.

Petrol engines of the opposed-piston type, both air and water cooled, were displayed on the stand of the Coventry Victor Motor Company, Ltd. In Fig. 2 we illustrate the four-cylinder engine with a bore and stroke of 78 mm., or a little over 3in., which has a designed output of 30 to 37 H.P. at 1500 to 2200 r.p.m., but which, by means of a different cam shaft, can be converted to develop about 72 H.P. at 4500 r.p.m. Even at this speed the engine was quite steady and did not, the makers state, require bolting down to the test bed. The engine is very compact, measuring only 21in. by 23in., with a height of 16½in. These engines are fitted with a simplified starting gear, which is worked from the half-speed cam shaft, instead of the crank shaft, and is claimed to give a quicker start up without any risk of back-firing. The engines are forced lubricated by a gear pump driven from the cam shaft at half engine speed.

The models exhibited included side valve engines of the type described and also overhead valve engines. Various types of reduction and reverse gears were also shown, including the Coventry Victor transome drive. The firm also exhibited a two-cylinder horizontal opposed-piston engine, designed for heavy fuel oil, with the firm's own fuel injection system. The cylinders of this engine have a bore of 75 mm., with a stroke of 78 mm., and at 1250 r.p.m. 5 B.H.P. is developed, at a fuel consumption of 0·462 lb.; the engine developing 10 B.H.P. at 2000 r.p.m., with a slight increase in fuel consumption. The engine with its water circulating and lubricating oil pumps, but without reversing gear, only weighs about 160 lb.

BROOKE MARINE MOTORS, LTD.

A novel single-cylinder, two-stroke engine with a designed output of 2 to 5 horse-power, was shown on the stand of Brooke Marine Motors, Ltd., of Lowestoft, and is illustrated in Fig. 3. It is mounted on a bracket-like bed-plate, which allows the unit to be screwed down by only four bolts, arrangements being made to tilt it to the desired angle for the propeller shaft. When the boat is laid up, the unit can be easily removed and used for belt driving, or generator work. The clutch and thrust block are in one with the motor, and the propeller tailshaft may be run in a stern gland only, no stern tube being necessary. The cylinder has a bore of 61 mm., or 2·4in., with a stroke of 67 mm., or 2·64in., and the overall length of the engine is 17in. Its rated output is 2 H.P. at 1000 r.p.m., 4 H.P. at 2000 r.p.m., and 5 H.P. at 3000 r.p.m. Besides several examples of petrol engines, ranging from that described up to a 100 B.H.P. engine, the firm exhibited a two-cylinder model of the new Brooke heavy fuel oil engine which has a 4½in. by 4½in. cylinder, and develops 10 H.P. at 1000 r.p.m. The cylinder head carries the air inlet and exhaust valves and a central fuel valve. The Bosch fuel injection and pump are used. Starting from cold is effected by lowering the compression pressure in one cylinder by means of a hand operated compression release. The lubricating system works under pressure and does not call for special comment. An air-cooled exhaust manifold is used, and is embodied with the silencer for the air intake. The engine, which is equipped with a Brooke epicyclic reverse gear, is fitted with an electric starting equipment and reverse gear, and it weighs 797 lb., its overall length being 4ft. 3in. At 1000 r.p.m., with an output of 10 H.P., the fuel consumption is 4·8 pints per hour.

NORRIS, HENTY AND GARDNERS, LTD.

Among the five engines shown on the stand of Norris, Henty and Gardners, Ltd., of London, we have chosen for illustration the new four-cylinder marine engine illustrated in Fig. 5. It operates on the four-stroke cycle, and has an output of 66 B.H.P. at 800 r.p.m., the bore and stroke of the cylinders being 5½in. and 7½in. respectively. The cylinders are larger than those of engines of the same type previously manufactured. This new range of engines comprises units with three, four, five, six and eight cylinders, giving at a standard speed of 800 r.p.m. a power output range of 51 up to 136 B.H.P. The small engine is arranged for hand starting, but for the largest sizes compressed air starting is employed, and an apparatus for the compression, storage and distribution of the starting air is provided. When desired, electric starting motors can be supplied.

PARSONS OIL ENGINE COMPANY, LTD.

We illustrate in Fig. 7 the largest of the engines exhibited on the stand of the Parsons Oil Engine Company, Ltd., of Town Quay Works, Southampton.

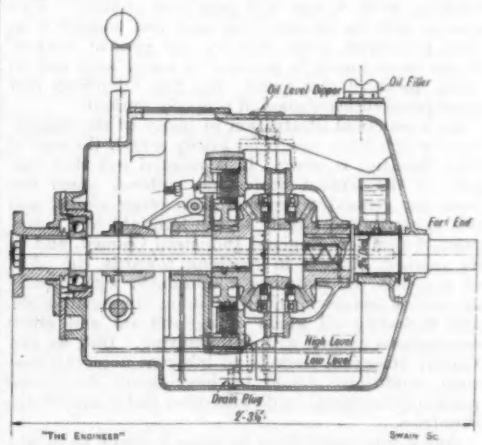


FIG. 8—REVERSE GEAR—PARSONS

It has six 4½in. by 5in. cylinders, and is designed to develop 100 H.P. at 2000 r.p.m. This engine is entirely constructed in aluminium alloy, with the exception of the cylinder block, and is provided with forced lubrication and oil cooling systems. Two systems of ignition are used, namely, a magneto with impulse starter and an H.T. coil and distributor. These are synchronised to work together on separate plugs situated on either side of the cylinders. The

specially designed combustion head is machined all over, ensuring that the compression ratio and power output of all cylinders is the same. Down-draught carburetters have now been standardised, working in conjunction with a mechanical fuel pump, so that the engine is quite independent of the relative position of the fuel tank.

Two other petrol-paraffin engines exhibited included the re-designed four-cylinder engine, with 2¾in. by 4in. cylinders, and a designed output of 12 to 24 H.P. at 1000 to 2000 r.p.m., and a four-cylinder engine of 25 to 45 H.P. output at 1000 to 1800 r.p.m., with 3¾in. by 5in. cylinders.

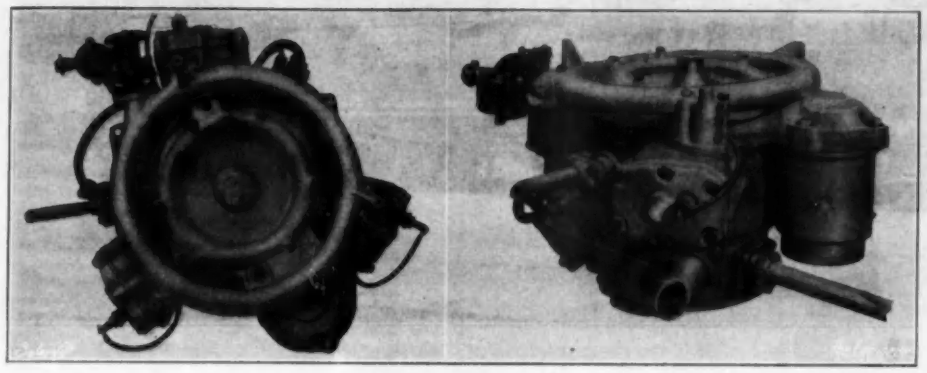


FIG. 9—10-30 H.P. RADIAL THREE-CYLINDER ENGINE—BIRMAL BOATS

We illustrate in Fig. 8 one of the firm's standard self-contained reverse gears, which is complete with single-lever control and automatic lubrication, and is designed to transmit powers up to 5 B.H.P. at 100 r.p.m. The gear, which may be supplied with or without reducing gear, embodies the standard design used on the Parsons engines. We also noted on the stand a range of circulating water pumps, which are now supplied to many builders.

THE AILSA CRAIG MOTOR COMPANY.

The Ailsa Craig Motor Company, of Strand-on-the-Green, Chiswick, showed several examples of the Ailsa Craig engine working on the Acro airless injection principle, and utilising heavy fuel oils. We have chosen for illustration, Fig. 6, the six-cylinder model, which has a designed output of 36 to 60 horse-power, with 3½in. by 5½in. cylinders. The monobloc crank case casting carries renewable liners, which are made of centrifugally cast iron. The pistons are of nickel iron and have four hardened piston rings and one scraper ring. The cover enclosing the overhead rocker gear has a connection to the crank case, and is furnished with an air intake cleaner and a device to absorb all the crank case fumes.

Another interesting exhibit on the same stand was a twin-cylinder opposed-piston petrol engine, designed to fit under a thwart or cockpit floor. It has a 2⅜in. by 2½in. cylinder, and develops 4 to 6 H.P. at 1000 to 3000 r.p.m. With reversing gear the engine only weighs 140 lb., and by adding a 2 : 1 reduction gear weighing 28 lb., a 14in. propeller can be easily driven. A four-cylinder, 12 to 20 H.P. overhead valve petrol engine, with a special high-efficiency head, for the use of low-grade petrol, was also exhibited.

BIRMAL BOATS.

Undoubtedly one of the novel engines in the Exhibition was the Birmal Tri-Star marine petrol engine illustrated in Fig. 9, above. It has been designed and is built by Birmal Boats, of Belvedere-road, Southampton, a branch of the Birmingham Aluminium Casting (1903) Company, Ltd., of Smethwick. As our illustrations show, the engine has three cylinders with inclined side valves, which are radially disposed around a vertical single-throw crank shaft, fitted with slipper type big-end bearings. The drive from the crank shaft is taken through spiral bevel gears which run free on a lay shaft, the forward neutral and reverse drives being obtained by two sets of coil spring clutches, whilst the propeller thrust is taken by a double thrust bearing. The arrangement makes it possible to incorporate a reduction gear of either 1·7 : 1 or 2 : 1, as may be required, with a 100 per cent. reverse. The engine is complete with a lighting dynamo and starting equipment with coil ignition. The exhaust manifold is water jacketed, and is in one with the main casting. The cooling water is circulated by the pump first to the gear-box cooling water jacket, then around the exhaust manifold, and finally to the cylinder jackets. The engine is mounted on two bearer type flanges, which form a part of the main casting. The cylinders are 77 mm. by 78 mm., and the outputs are 10 H.P. at 1000 r.p.m. and 30 H.P. at 3500 r.p.m. Without electrical equipment the complete engine weighs 195 lb., an additional 105 lb. being required for the batteries and the complete electrical equipment. The engine was shown installed in one of two all-metal, Birmabright alloy boats, which formed the main exhibit on the stand.

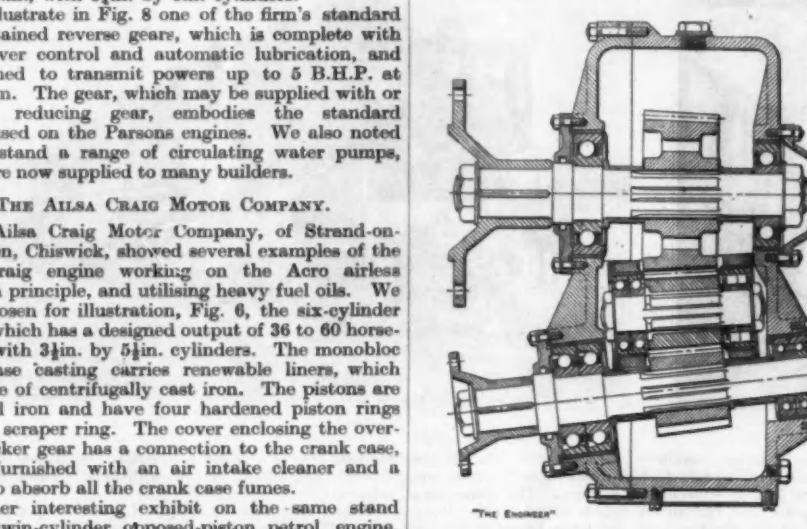


FIG. 11—1400 H.P. RETURN DRIVE GEAR-BOX—VOSPER

VOSPER AND CO., LTD.

Three typical motor boats, 18ft., 16ft. and 12ft., and several Vosper engines, were displayed on the stand of Vosper and Co., Ltd., of Portsmouth. There was also exhibited a return drive gear-box, designed by Mr. Fred Cooper, M.I.N.A., of Hythe, Hants, for a 27ft. 6in. hydroplane, also designed by him for Mr. Horace E. Dodge, which will compete in next year's Gold Cup Race in America.

The gear-box, which is illustrated in Fig. 11, has several interesting features, amongst them being the fact that it can be assembled with either two or three wheels, consequently allowing the direction of rotation on the propeller shaft to be changed at will. The advantage of this is that the torque reaction of the propeller can be arranged to suit whichever direction of circuit any actual race is to follow. Another feature is the method of jointing used. By jointing the box in a vertical plane near the rear end bearings, a complete assembly of gear and pinion, and in this case on occasions, also the idler wheel, can be made in the open, thereby ensuring perfect meshing of the teeth, which is so important for extremely fine angle wheels. The body of the box can then be bolted up to the face and the front end bearings assembled. A thrust tube is arranged on the front end of the box on the propeller shaft line, thereby relieving the holding-down bolts of any tripping loads that otherwise would have to be taken care of. The box is designed to transmit 1400 H.P. at 3300 r.p.m. at the input shaft, and weighs only 168 lb. complete (dry weight), and, as drawn with idler wheel, gives a 2 : 1 increasing ratio. It is water-cooled on the bottom half only, and is lubricated by splash lubrication from the box itself, the lower pinion being half submerged in oil.

The box is of cast "Birmabright," a salt water resisting alloy, the shafts and wheels being of special high-tensile steel. All bearings are of the Ransomes and Marles type, and the wheels and shafts were supplied by E.N.V. Engineering Company, Ltd. The box was cast and machined by Vosper and Co., Ltd., of Portsmouth, who also carried out the assembly work.

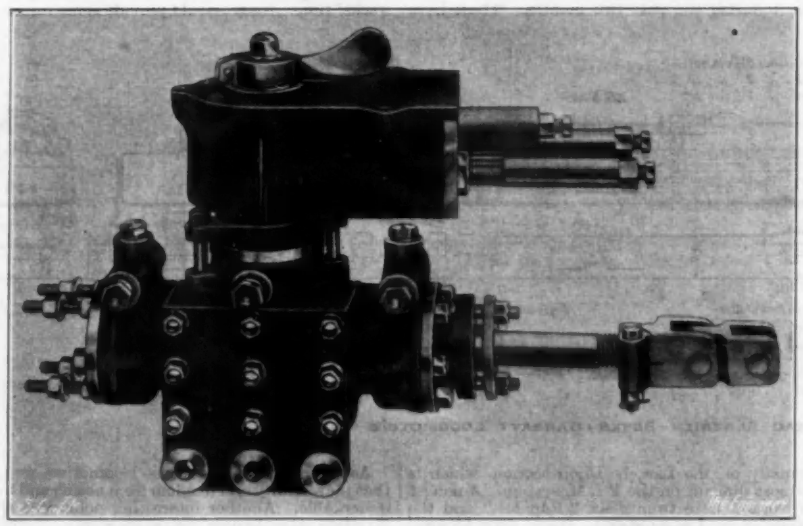
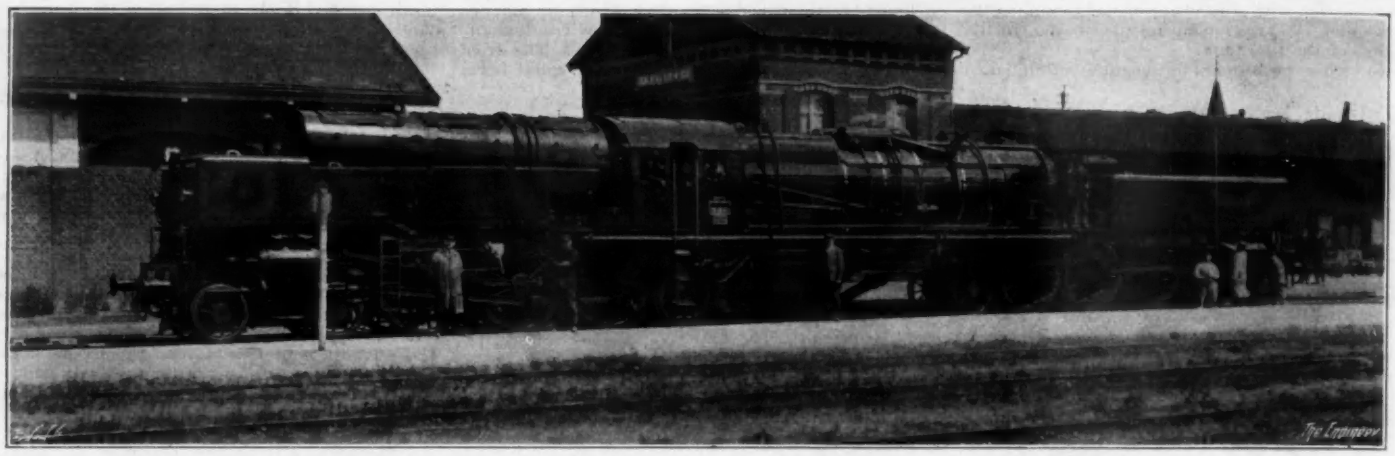


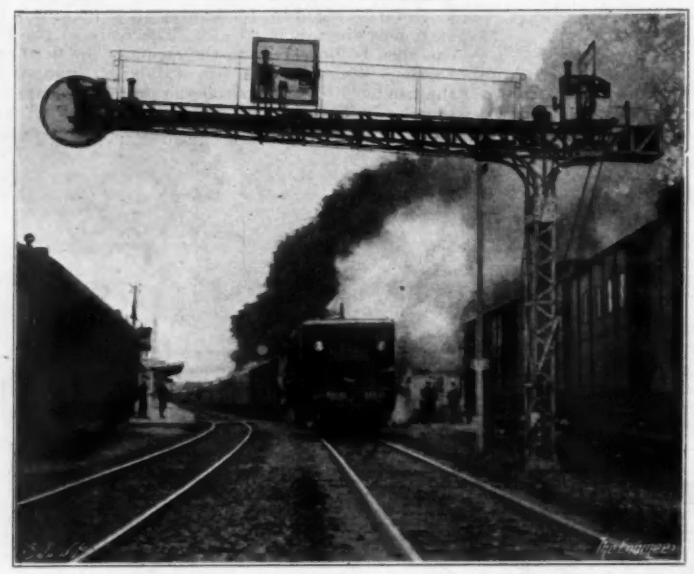
FIG. 10—RAM UNIT OF TELEGRAPH CONTROL GEAR—HYLAND

HYLAND LTD.

An interesting display of hydraulic telegraph control gear was shown on the stand of Hyland Ltd., of Wakefield. We illustrate in Fig. 10 the hydraulic ram unit which is employed and which works in conjunction with a small oil pump driven by the engine, and miniature telegraph transmitters of the standard type operated by copper chain and solid-drawn wire transmission gear, which may be fitted in the chart room or some distance aft. The oil pump continually circulates a supply of pressure oil from a small container to the ram unit and back to the source of supply. The upper valve rods, shown in Fig. 10, are connected to the telegraph transmitter, while the main, lower, ram is attached to the engine throttle. When the telegraph handle is moved to the "Ahead," "Stop," or "Astern" positions, the oil pressure acts through ports in the ram casing, and moves the engine control lever into the appropriate position. Further movement from "Slow ahead" to "Full ahead" causes the throttle to open wider until maximum speed is attained. There is no oil pressure in the pipe line until the telegraph is operated, and immediately the desired control position has been reached the pressure on the main ram is released. We found the gear very simple in its operation, and it has, we learn, been successfully adopted, after Admiralty tests, for Royal Air Force tenders.

BEYER-GARRATT ARTICULATED LOCOMOTIVE FOR ALGERIA





Articulated Express Locomotive for Algeria.

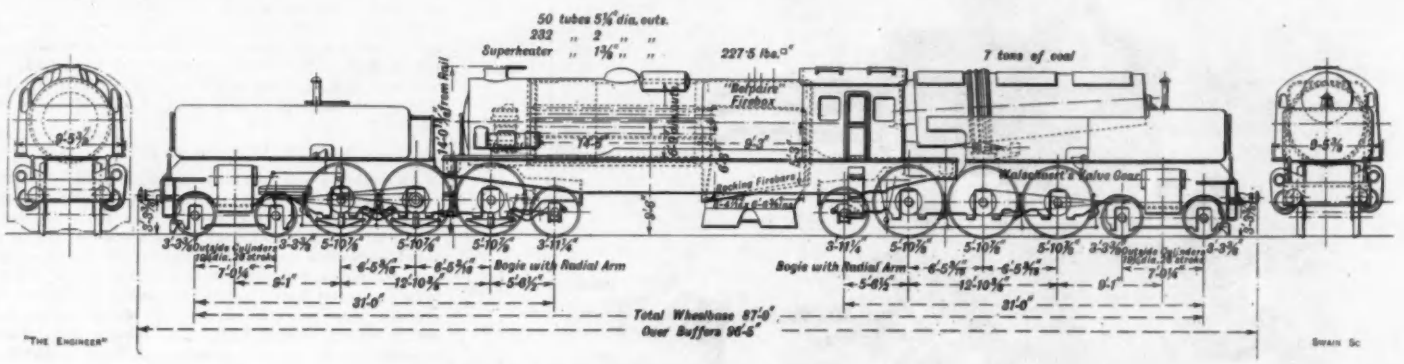
MANY designs of articulated locomotives have been invented and a few types still exist. They have been used mainly for heavy collar work, on steep gradients, with sharp curves, and though some of them have shown themselves capable of running at fairly high speeds, they have never been regarded as express engines. Particular interest therefore attaches itself to a 4–6–2, 2–6–4 "Beyer-Garratt" for Algeria, which, during recent trials in France, has proved itself fitted for ordinary express passenger work. It was designed by Beyer, Peacock and Co., Ltd., in collaboration with the Société Franco-Belge de Materiel de Chemins de Fer, at whose works at Raimes in the North of France it was constructed. Several views of it are given above and the accompanying diagram shows other particulars. The gauge of the sections on which it will run is 1·44 m., or slightly over the British standard of 4ft. 8½in., and it has the largest driving wheels, namely, 5ft. 10⅜in., yet used on Beyer-Garratt designs. The speed records indicate very free running. The maximum of 75 m.p.h., at which speed the revolutions are 356 per minute and the piston speed 1536ft. per minute, are high for such a driving wheel diameter.

The cylinders, four in number, are 19½in. by 26in., and the boiler pressure 227·5 lb. per square inch, giving, at 75 per cent. a tractive effort of 47,300 lb. The boiler is of exceptionally large diameter, namely, 6ft. 9in. in the centre, with 3087 square feet of evaporative surface and 743 square feet of superheater surface. The grate area is 54·6 square feet, but owing, it is believed, to the depth and form of the fire-box and the large barrel diameter, remarkably good evaporation has been obtained. The designed weight of the engine in running order is 197·7 tons. As will be seen from our illustration, the tender is fitted with a Beyer-Peacock self-trimming bunker, which, we are informed, enables the large grate to be dealt with easily by one fireman.

Prior to the despatch of this locomotive to Algiers (P.L.M. Reseau Algerien), it was decided to test this new articulated locomotive in France, and many runs have been made with it during the past two months. These have been principally on the Laroche-Dijon section, which is one of the most difficult on the P.L.M. system. Amongst the trains worked were twenty-six "Rapides" and the total distance covered amounted to nearly 6000 kiloms., or about 3500 miles. The loads behind the tender in the main tests were the normal "Rapide" passenger trains, which are probably the heaviest in Europe. All the trains were handled with ease, the average speed between Dijon and Laroche being practically 53 miles per hour, while a maximum of 75 miles per hour was attained. From Laroche to Blaisy-Bas is a long climb, about 82 miles, or about one and a-half hours at full regulator. An examination of the speed record of a train which ran between Laroche and Dijon on September 20th shows quite remarkable steadiness and high average speed up the long gradient, which rises 1040ft. in about 80 miles. The schedule time for this trip is 2 hours 5 minutes, but it was covered in 1 hour 55 minutes. A few additional figures may be of interest:—

Train No. 513—20/9/32, Laroche–Dijon—up bank. Load 635 tonnes (train not heated). Average speed throughout 51·3 m.p.h.

Train No. 610—14/10/32, Dijon–Laroche—down bank. Load 558 tonnes (train heated = 10 per cent. additional load). Average speed throughout 52·6 m.p.h. On this trip the maximum speed of 75 m.p.h. was attained. In both cases the schedule speed was considerably exceeded. The engine has now been sent to the works of the P.L.M. at Lyons to be fitted with indicators, and we understand that full dynamometer tests will be begun in two or three weeks' time. They should provide some interesting data.



P.L.M. RESEAU ALGERIEN—BEYER-GARRATT LOCOMOTIVE

As regards the riding of the locomotive, we understand that the stability and freedom from nosing and hunting was remarkable. Another interesting point was that in one direction the locomotive always ran bunker first, a characteristic feature of this type. We learn, too, that no trouble of any kind was experienced, all bearings running cold, while not a trace of steam was visible from the steam pipe arrangement. These facts tend to show the great advance that has been made in recent years in the perfection of details of articulated engines.

Up to the present the available data are rather scanty, but the main fact that this articulated type of locomotive is quite suitable for hauling heavy trains at high express speeds has been fully confirmed.

TWO COLD SAWING MACHINES

NOBLE AND LUND, LTD., FELLING-ON-TYNE, ENGINEERS

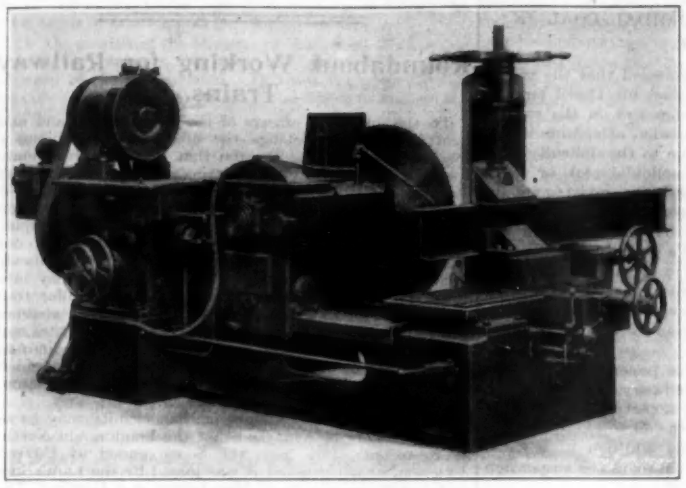


FIG. 1—COLD SAWING MACHINE FOR JOISTS, ETC.

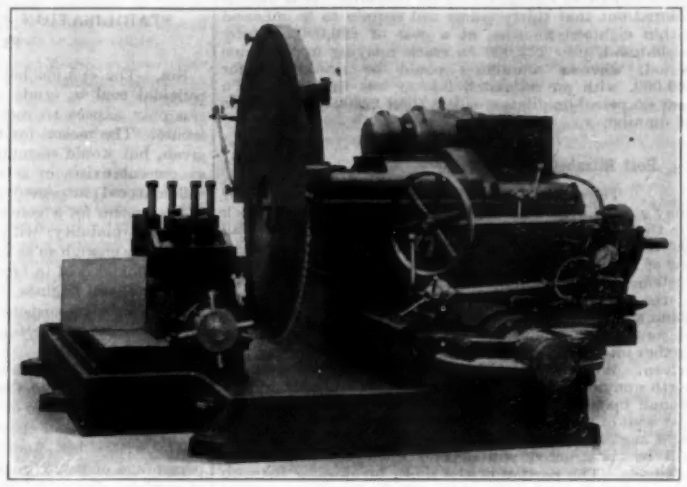


FIG. 2—COLD SAWING MACHINE FOR NON-FERROUS INGOTS

Some New Cold Sawing Machines.

THE cold sawing machines illustrated by the accompanying engravings have recently been manufactured by Noble and Lund, Ltd., of Felling-on-Tyne, to utilise special "Insto" high-speed steel saws with replaceable segments made by Thomas Firth and John Brown, Ltd., of Sheffield. It is claimed for these saws that, by improving the shape of the teeth, cutting times and power consumption have been much reduced. All the three machines illustrated were specially designed to take advantage of the capabilities of the saws, and have spindles of nickel chrome steel of large diameter, while the driving gears are forged solid with the spindles to eliminate keys. On each machine the driving gears are made of heat-treated steel and run in a totally enclosed oil-bath. Hydraulic feed has been adopted for all three designs, the oil being supplied by a pump to the cylinder on the saw carriage. The advantages of hydraulic feeding of saws are now so well known that it is hardly necessary here to point out that the rate of feed automatically adjusts itself to the thickness of the section being cut. A pressure gauge is fitted for the observation and adjustment of the "cutting" pressure.

The photograph reproduced in Fig. 1 shows a machine to which blades from 30in. to 38in. in diameter may be fitted, its sawing capacity varying accordingly. Fitted with a 38in. blade it can deal with bars 14in. in diameter or 13in. square and "I" beams up to 24in. by 11½in., as well as many other sections, such as channels, angles, &c. If bevel cuts are required the vice column, the horizontal jaw and the work roller are all mounted upon a table capable of swivelling to an angle of 45 deg. The drive to the saw blade is by Texrope from a motor mounted at the end of the machine furthest from the work table through a gear-box providing cutting speeds of 40ft., 54ft., 68ft. and 90ft. per minute suitable for cutting steels the tensile strength of which ranges from 20 tons to 50 tons per square inch, nickel chrome steels, &c. As far as possible the machine is lubricated on the Tecalemit pressure feed system, and a large trough is provided within which the chips collect free from cutting lubricant. As an example of the productive capacity of the machine, the makers inform us that a standard "I" beam, 24in. by 7½in., was cut through in 55 seconds, while a 6in. diameter bar needed 1¼ minutes.

The next illustration, Fig. 2, shows a machine specially designed for sawing off the outer skin from aluminium and other non-ferrous ingots before rolling, and capable of accommodating ingots up to 36in. by 18in. and round bars up to 18in. in diameter. The ingot is gripped in the vice at the end of the machine in such a way that the part to be sawn off is overhanging the table. Exact adjustment is obtained by cross-movement of the saw after the work has been clamped down. A 10 H.P. motor mounted on the saw carriage drives the blade through multiple "V" ropes and a gear-box providing four speeds between 100ft. and 200ft. per minute, while the hydraulic mechanism will give rates of feed up to 28in. per minute. In order to accommodate both square and round billets, the vice jaws can be swivelled through 180 deg. They have flat faces on one side and "V" faces on the other. The saw guard, which is fitted with a hinged door, carries a chip remover consisting of a cast iron roller spring operating on the periphery of the blade. Special attention has been paid to the grouping of the controls, and the machine is rapid in operation, as the following figures, obtained on a duralumin ingot by the makers, demonstrate:—Size of cut, 35in. by 18in.; time, 8 minutes. Size of cut, 18in. diameter; time, 4 minutes.

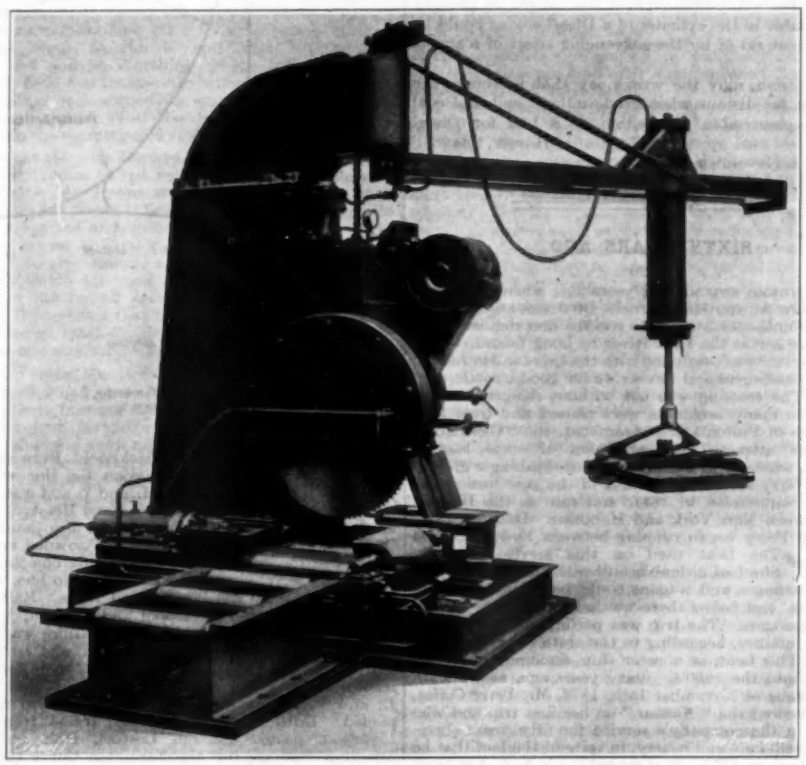


FIG. 3—CIRCULAR SAW FOR BRASS AND COPPER INGOTS

The third machine, of which a photograph is reproduced in Fig. 3, is designed for sawing off the heads of brass and copper ingots approximately 36in. by 26in. by 3½in. deep. It utilises a vertical motion of a 36in. wheel, which is driven by a 15 H.P. motor, mounted on the saw carriage, at a cutting speed of 200ft. per minute. The machine is specially designed for rapid production, and it is claimed that 150 ingots can be dealt with per eight-hour day, as the actual sawing time for a cut 26in. by 3½in. is 60 seconds. A jib crane fitted with a quick-acting steel grab is slung from the main column of the machine. By its use the next ingot can be picked up while the last is being sawn, and placed at the left-hand end of a roller table ready to be rolled into position. At the conclusion of the sawing operation the sawn ingot may be removed by the crane. When in the sawing position the work is clamped down by a hydraulic vice. The cutting lubricant is supplied to the saw by a separately motor-driven pump, and it is collected in the bed of the machine, whence it drains into a trough in the foundations.

South African Engineering Notes.

(By our South African Correspondent.)

Fuel Research in S.A.

IMPORTANT work by the Fuel Research Institute of S.A. is foreshadowed in the first annual report of the Fuel Research Board, which was issued in August. Although the work of the technical branch of the Institute was curtailed to some extent, by reason of the fact that the Institute will not be housed in its own laboratories until towards the end of the present year, the Board decided that it would be possible to undertake the following matters:—(1) A classification and a physical and chemical survey of coal seams; (2) investigation of the effect of catalytic treatment of coal on the clinkering and combustion characteristics; (3) combustion problems. The first of these will constitute for the present, says the report, the Institute's most important work. The Institute will have fairly complete equipment for carrying on the survey, and it is anticipated that it will proceed smoothly, unless unforeseen difficulties arise. It is proposed, for the first few years, to make surveys only of existing coal mines, and to carry out a comprehensive study of the characteristics of the mines investigated, Transvaal and Natal mines being surveyed alternately. Proposed and probable investigations are:—A study of the hydrogenation of coals and tars, more especially the suitability of S.A. coals for the hydrogenation process, and the investigation of the suitability of S.A. tars, when treated with asphalt, bitumen, or other material, for road-making purposes. Investigations to be continued are a study of the economics of pure alcohol production from maize, and a study of combustion on railways. Other matters considered by the Board during 1931 were a scheme for establishment of works for the production of oil from coal and shale and other materials, boring for oil, and co-ordination of research work affecting industrial developments.

Trackless Trams and Omnibuses.

The Portuguese Port Authority of Delagoa Bay, or, as the town is now usually called, Lourenço Marques, has decided after weighty consideration, in the course of which its technical experts visited several Union towns, to adopt trackless tramcars and has resolved to spend a sum of £25,000 as a first instalment of the scheme. In the Union there is already one with a trackless tramcar system, and East London is scrapping its tramways and intends to substitute omnibuses at once. Municipal electrical engineers are becoming more insistent month by month that the rail tramway must be abandoned. They point out the dangers to which passengers by the tram are exposed, owing to tram stops being in the middle of the street, with a rush of other vehicular traffic on both sides threatening people coming from the pavements to board, or alighting from trams to proceed to the pavements. There is also the great fault of want of mobility, so that if in furnishing a growing suburb with tram facilities a miscalculation is made as to where the main development will take place, it means incurring the expense of taking the lines up and relaying them through the more populated districts. But, even so, it is pointed out that tramcars cannot compete with the omnibuses, either as regards quickness of travel or cheapness of running. The case made out is very strongly against the

tramcars. Mr. L. M. Barry, the manager of the Johannesburg Tramways, anticipates that there will be a greater loss than the £60,000 which had been anticipated for the current year's working. There will be a loss on the southern suburbs system alone of £50,000, and he says trams cannot be recommended for this area. It is further pointed out that thirty trams will require to be renewed within eighteen months, at a cost of £96,000, if fully modernised, plus £11,000 on track relaying in the same period, whereas omnibuses could be introduced for £69,000, with an estimated loss of less than £15,000 a year on petrol omnibuses or less than £2300 loss on crude oil omnibuses.

Port Elizabeth Harbour.

The work of constructing the new north arm or quay wall of what is to be, when completed, an inner dock for the port is progressing to schedule. The quay wall has been carried out, and 332ft. completed above water, out of the 800ft. which is to be the first instalment of the harbour. The random mole, some couple of hundred feet to the north of the new quay, has been completed for about 800ft., while the staging to carry the stones and *débris* to continue the mole has been taken out about 1200ft. further into the bay, leaving another 1000ft. of piles to be driven. When completed, the water space between the north quay and the mole will be filled in and will provide ground upon which to erect warehouses, &c. When the east wall of the harbour, which is to be run out at nearly right angles to the big south breakwater as a rubble mole, will be constructed will depend upon when funds are available. The portion of the south breakwater between the contemplated rubble mole and the foreshore will, of course, form the southern side of the harbour some day, while the foreshore between the root of the breakwater and the root of the north jetty, when properly aligned and provided with a quay wall, will be the west arm of the harbour, the entrance to which will be an opening of about 600ft. between the outer end of the north quay and the outer end of the contemplated rubble mole from the south breakwater. Owing to erosion, through the action of the heavy seas on the elbow of the big south breakwater, where the arc of arm is shortened and the breakwater swings boldly from east to north, it has been necessary to throw a blanket of 40-ton blocks on the seaward side. For a distance of over 100ft. on the upper and second tiers of the sloping bond, the sea had cut so deeply into the solid concrete that part of the outer construction track for some time was suspended in space, and blasting had to be resorted to for the purpose of cleaning up the scrag ends, so that solid blocks could be reset.

Electricity Notes.

At Pretoria the power station extensions in connection with the installation of the 12,500-kW, 12,000-volt turbo-alternator are rapidly nearing completion. The alternator, together with all the auxiliaries, has been erected and the testing is understood to have been satisfactorily carried out. Provided no unforeseen circumstance arise the whole of the plant in connection with the extensions should be ready for testing towards the middle of November. Having entered into an agreement to supply electricity to the S.A. Iron and Steel Industrial Corporation, an order has been placed for two further 12,000-volt feeders equipment, with a rupturing capacity of half a million kVA. Tenders have already been received and considered, but the result has not yet been announced. During the past year the electricity department of Port Elizabeth, in spite of depressed trade and industrial conditions, sold 24,185,075 units. This broke all previous records.

Johannesburg New Station.

The Johannesburg new station is now approaching completion. It has been urgently needed for twenty years, owing to the considerable increase in the traffic handled and to the growing importance of the city as the centre of the world's largest gold-producing industry. The total estimated cost of the reconstruction scheme is £740,000, of which some £290,000 is being expended on alteration of the yard lay-out, the provision of additional platforms, signalling apparatus, the construction of subways, the installation of gantries, the acquisition of an additional strip of land, and the alteration of the sewerage and storm-water drainage arrangements. The station building will have four storeys above the street level. Subways will afford easy access to and egress from the eight long platforms, which are a feature of the new station. In order to provide for the accessibility of all essential sections and to separate, as far as possible, the concourse—with its waiting-rooms, lavatories, refreshment and dining room—from the working section of the station, the concourse has been placed on the lower ground floor level, which is also the level of the subway. The concourse measures 164ft. by 124ft.

New Rhodesian Railway.

The new section of the Rhodesian Railway system which was brought into commission on September 19th has a notable feature about it, in that it will be a factor of importance in bringing the Victoria Falls within two and a-half days' rail journey of Table Bay. The traveller leaving Cape Town by the mail boat train at 11.40 on Monday morning will arrive at the Falls at 10.45 on Wednesday night. The new line, which starts just north of Wankies and rejoins the old trunk railway just before reaching the Falls, takes a deviation to the west. The distance from Wankies to the Northern Rhodesia border, *viâ* the old line was 75 miles and 86½ by the new route. The old line is now definitely discarded as a railway route, but much of its length will probably be brought into service as part of the main highway to the Northern Rhodesia gateway at the Zambesi. The speed of the trains at times will reach 50 miles an hour, and one engine can take 2½ times the upload over the new line that it can take over the old one. Whereas 81 per cent. of the curves on the old line limited the maximum speed, this is only affected by 8 per cent. of the curves of the new lines.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

STABILISATION OF COLLOIDAL COAL IN FUEL OIL.

SIR,—The opinion has been expressed that the use of colloidal coal in crude oil as a fuel for Diesel engines can only expect to receive development in the remote future. The reason for this expression of opinion is not given, but would seemingly be due to the difficulty that at present exists in getting the colloidal coal, or semi-colloidal coal (suspenoid, as other writers term it) to remain in suspension for a considerable time, a difficulty arising from the inability, with present methods, to grind the coal finely enough so as to make it a perfect colloid.

If colloidal coal in crude oil is to become popular as a fuel for Diesel engines, it is essential that the coal shall remain in perfect suspension for several months, otherwise it will be impossible for garages and other oil stockists to stock the fuel.

Professor J. S. S. Brame, in his paper recently given before the Society of Chemical Industry, states that the stability of suspension of particles of coal in oil is probably due to the emulsoid character of the oil.

The writer has found that the addition of a small percentage of water to crude oil improves the suspension of particles of colloidal coal in the oil.

The addition of second and third colloids also considerably improves the suspension of the first colloid. For instance, second and third colloids such as colloidal clay and colloidal graphite (in the form of Acheson Oildag) about doubled the period of suspension of colloidal coal in the crude oil.

The clay is of no value, other than as a stabiliser of the colloidal coal, but the graphite has lubricating properties that are of value if the fuel is to be used in a Diesel engine.

The Brownian movement of the second and third colloids seemingly induces a stronger Brownian movement in the colloidal coal, and so prolongs the period of suspension.

The writer doubts very much whether the law of Stokes and Lunnon on the rate of fall of particles in a liquid applies when the liquid contains a colloid in suspension, and the falling particle is of practically colloidal size. No doubt a modification of that law could be found that would apply.

The ash from the colloidal coal that might be thought to give trouble in the cylinder of a Diesel engine could be effectively got rid of by the scavenging effect of a supercharger.

In conclusion, may the writer say that he thinks the time is not far distant when crude oil and colloidal coal will be a practicable proposition as a fuel for Diesel engines?

HARRY SHAW.

Heywood, November 3rd.

SIXTY YEARS AGO.

TWO HUNDRED AND NINETY years ago, when New York was still New Amsterdam, Cornelis Dirchsen, an enterprising Dutch innkeeper, started to run the first regular ferry-boat service across the East River to Long Island. Until 1814 the service was continued with the aid of sail or rowing boats for passengers and flat scows for goods, cattle, and wagons. The crossing was not without danger, and by gale or tide many accidents were caused and lives lost. The success of Fulton's first steamboat, the "Clermont," in 1807–08 attracted the attention of some leading capitalists, who saw in it a means of establishing a greatly improved ferry service. The first of the new ferries was placed in commission in 1811, and ran on the Hudson River between New York and Hoboken. In May, 1814, the Fulton Ferry began running between New York and Brooklyn. The boat used on this service was the "Nassau." She had a double hull with the wheel at the centre. Carriages and wagons could pass fully laden on to her deck, and below there was a room for the shelter of the passengers. The trip was performed in from five to twelve minutes, according to the state of the tide and weather. This boat, or a sister ship, remained in service until well into the 1860's. Sixty years ago, as we learn from our issue of November 15th, 1872, Mr. Peter Coffee, who had steered the "Nassau" on her first trip and who remained in the company's service for fifty years thereafter, was still hale and hearty, in spite of the fact that he had been born in 1777. It is probable—in fact, it is practically certain—that there are some still alive who knew Mr. Coffee. The linkage of two lives is still sufficient to cover the whole history of steam navigation. . . . In the same issue we reprinted the address delivered by Professor Fleeming Jenkin at the opening of his class at Edinburgh University. We would like to think that among his audience was a tall, thin, dark, and delicate young man named Stevenson, but the facts are against such a supposition. A year or so previously, the future author of "Treasure Island" had "wiped the dust of granite off his hands," and abandoning the family profession of engineering, had taken to the study of the law. There is little or nothing in Jenkin's address as we read it to-day which would suggest the personality of the man as Stevenson has sketched it for us in his "Memoir." Jenkin devoted his remarks to two main subjects, the value of professors of engineering and the lock-and-block system on railways. On the first subject he delivered himself of a number of platitudes and directed an attack against those who resisted change and the advancement of knowledge. On the second-named subject he revealed himself as a strong advocate of the proposal to make the lock-and-block system compulsory by Act of Parliament on all our railways. In his final sentence he adjured his hearers to "retain the enthusiasm of youth for what is new and true, and the honest indignation of youth at time-serving cowardice and lethargy." Possibly there was a greater connection between the two subjects of his address than is now apparent.

Roundabout Working for Railway Trains.

To the operating officers of the London, Midland and Scottish Railway belongs the credit of introducing a method of working at Preston that is going to eliminate a source of great delay to the trains that pass through that station. In order to appreciate what is being done it should be remarked that the large number of excursion trains from the Lancaster and Carlisle line to Blackpool have to run into Preston Station, be reversed, and go out again, getting on to the Blackpool line at Maudlands Junction. The return trips also call for a journey into Preston Station. There is also a popular circular tour through the Lakes which begins with a journey by steamer from Fleetwood to Barrow and returns *viâ* Lancaster and Preston. This tiresome occupancy of the main lines at Preston and an exchange of engines have been avoided by the use of some of the connecting lines south of Preston, as shown on the accompanying sketch.

As the history of the lines in that vicinity may be of interest it may be remarked that the London and North-Western main line from the South ended at Euxton Junction, at which point it was joined by the Lancashire and Yorkshire line from Manchester and Bolton. The London and North-Western's own system was resumed at Maudlands Junction and ran thence to Carlisle. At Maudlands Junction a line goes off in a north-westerly

direction to Fleetwood and Blackpool. Between Euxton Junction and Maudlands Junction the line was owned jointly by the L. and N.W. and L. and Y. and was known as the North Union. The Fleetwood and Blackpool line was known as the Preston and Wyre and also jointly owned. Of the North Union the L. and N.W. owned two-thirds; of the Preston and Wyre it owned only one-third. Thus the L. and N.W. always worked the main line, whilst the L. and Y. worked the Preston and Wyre. Railway communication between Liverpool and Preston, Blackburn, Accrington, Burnley, and East Lancashire was given by the East Lancashire Railway, which was amalgamated with the L. and Y. in 1859. Since 1862 there has been the most friendly arrangements between the L. and N.W. and L. and Y. companies and their competitive traffic was pooled. Until the early 'nineties trains from and to Liverpool passed through Lostock Hall and Preston Junction stations, but the Farington Curve then gave a shorter route. The Farington New Curve was put in about thirty years ago and allowed for the heavy traffic between the East Lancashire towns and Blackpool to cross the path of the main line trains otherwise than on the level.

In the "roundabout" arrangements now introduced trains for Blackpool from the Lancaster direction run through Preston without stopping, travel over the old East Lancashire to Preston Junction, then turn west and through Lostock Hall and afterwards by Farington New Curve reach the west side of the main line and proceed on the Blackpool lines at Maudlands Junction without any fouling of trains in the opposite direction. Trains for the North from Blackpool take the reverse route. The extra journey of some six miles is made in less time than that taken in reversing and one engine works through to destination.

CRACKS in ingots have been traced by an American steelmaker to tar-coated moulds. This conclusion is based on tests made by spraying the moulds alternately with tar and with graphite, and using the same complement of moulds on the same heat of steel.

Railway and Road Matters.

EIGHT locomotives of the L.M.S. Railway's "Royal Scot" class are to be named after famous Territorial Regiments of London and the Home Counties.

ON the motion of the Minister of Transport, the London Passenger Transport Bill was, on October 27th, carried forward to the next session. This was the equivalent of giving the Bill a second reading, and it will now go to the Committee stage.

A NUMBER of nitralloy crank pins have been in service on various locomotives belonging to the German State Railways for a number of years, with encouraging results. After running 260,000 miles one set showed slight wear, but, after grinding and re-nitriding, were put back, and have now over 300,000 miles to their credit. Other pins have been in use for seven years without requiring attention, but the most noteworthy fact is that the wear of the bearings has been reduced.

THE Victorian Government Railways did uncommonly well last year in their financial operation. Their revenue fell from £10,008,358 in 1930–31 to £9,454,304 in 1931–32, a decrease of £554,054. The expenditure was, however, reduced from £7,695,144 to £6,340,542, a reduction of £1,354,602. The result was that the ratio of expenditure to receipts was 76·06, as compared with 76·89 in the previous year. The net earnings per train-mile were 4s. 0·64d., as against 2s. 10·82d.

ANSWERS to questions addressed to the Minister of Transport on October 20th and 24th respectively intimate that one passenger was killed as a result of accidents to trains during August last and another during September. These cannot, however, be of the character usually known as railway accidents, as the only passengers killed in train accidents since the fatal collision of December 18th last at Dagenham Dock station were the three who lost their lives in the derailment at Great Bridgeford on June 17th.

THE Ministry of Transport railway statistics for July last show that, when compared with the corresponding month of 1931, the number of passenger journeys was 3·4 per cent. fewer and the receipts from passengers decreased by 4·2 per cent. The freight traffic particulars relate to the four weeks ended August 13th, and record a decrease of 9·3 per cent. in tonnage, and of 12·5 per cent. in receipts. There was a decrease of 6·1 per cent. in the freight train mileage, whilst the average train load decreased from 118¾ to 114½ tons, and the net ton-miles per engine-hour from 436¼ to 430½.

SINCE the intimation herein on October 7th that the electrical services of the Southern Railway would be extended to Brighton and West Worthing in January, it has since definitely been announced that that will be done on Sunday, January 1st. In anticipation of that, trial trains began to run to and from Brighton on November 1st and to Worthing on the 8th. The new services will have five trains—one non-stop, two semi-fast, and one calling at intermediate stations—per hour from Brighton, and one for West Worthing. Additional trains will be run in the morning and evening.

ASKED what steps his Department had taken during the parliamentary recess to reduce the great loss of life from road accidents, Mr. Pybus replied that he had, in conjunction with the Home Office and the police, brought to their final stage the arrangements for a special investigation of the causes of fatal road accidents over a period long enough to give definite and reliable results. A form of return suitable for mechanical tabulation had been prepared for use by all police forces in reporting fatal accidents. He believed that by a more complete diagnosis of the causes of fatal accidents it would be possible to devise more effective methods to reduce their number.

A REPORT from Mr. Scott Main on a fatal accident to a porter who had to go into a tunnel once a week to exchange a long-burning signal lamp makes two suggestions which might obviously have been considered before. The first is that the work might be done at a time of day when no trains were likely to pass through the tunnel, and the second is that the man might have the assistance of a better guide than the duck-lamp he had to use. As Mr. Main remarks, in bad atmospheric conditions it is difficult to distinguish between the "six-foot" and the "four-foot," and, in fact, their rails. He recommends that some better form of lamp should be employed, say, acetylene.

THE inquiry by a Committee appointed by the Minister of Transport to consider the second pooling scheme lasted only the first three days of last week. The only opposition came from the Traders' Co-ordinating Committee and the three railway unions. When the first scheme was inquired into the men urged that any discharges, reduction in rank, &c., that might follow pooling should be compensated for on the same basis as those men affected by grouping under the Railways Act, 1921. The same plea is being made now. On the former occasion the unions' case was taken by Mr. A. G. Walkden, the secretary of the Railway Clerks' Association, but counsel, in the person of Sir William Jowitt, represents them at the present hearing.

THE very interesting case in workmen's compensation mentioned herein on July 1st was taken to the Appeal Court by the defendants, where the appeal was dismissed on November 2nd. Two men, who were employed by the Furness Shipbuilding Company in reconstructing a bridge at Canning Town for the London and North-Eastern Railway, were struck by an open carriage door on a passing London, Midland and Scottish train. Compensation was paid by the L. and N.E.R., and that company sued the contractors for its refund. The defendants pleaded that the origin of the accident was at Fenchurch-street and that it was outside the clause of the agreement between them that "the contractor shall be responsible for and provide against all risk and contingencies whatever that may arise at the works." Mr. Justice Branson, who heard the case originally, said that the accident occurred where the work was being done, and as the injured men were employed on the work, there was sufficient connection with the works to enable the plaintiffs to recover. The appeal was unanimously dismissed.

Notes and Memoranda.

IT is announced that Lord Macmillan has agreed to succeed, as President of the National Institute of Industrial Psychology, Lord D'Abernon, who has had to resign the position owing to pressure of other engagements.

AT about 800 deg. Cent. fire-bricks begin to lose their elastic properties, and are able to accommodate themselves plastically to deformation. The value of the coefficient of expansion up to 800 deg. Cent. is, therefore, of great importance, since it is intimately connected with the spalling resistance.

AN ingenious method of turning spherical surfaces of large diameter with apparatus not extending beyond the bed of the lathe, is described in Research Paper No. 467 of the American Bureau of Standards. The turning tool is attached to a wedge, which is drawn between two fixed pegs that give the desired curvature. The spherical form is not absolutely perfect, but is sufficient for most optical purposes.

IN the construction of multi-storied welded buildings the columns can be reduced from floor to floor in quite novel manner. Pieces which, in shape, resemble a wedge are cut from the end of the web of the larger section at points where the web joins the flange. To do this an oxy-acetylene or oxy-coal gas flame is used, and at the same time the flanges are heated and hammered into the correct line. The flanges and web are then welded together and form a column with cross section identical with that of the column which it is intended to superimpose.

SELENIUM is the most recent addition to the numerous refined metal products now being produced in Canada. It is obtained as a by-product in copper refining and was produced for the first time early in 1931 at the plant of the Ontario Refining Company at Copper Cliff, Ontario. Selenium finds its present chief market in the glass industry, where it is employed as a colouriser and for neutralising other colours. It is also used in the rubber industry and in the manufacture of selenium cells for television apparatus. It is generally sold either in the form of an amorphous powder or as small rods and buttons.

IN his presidential address to the Birmingham Metallurgical Society, recently, Mr. A. A. Jude said that in metallurgy an enormous complexity was being fostered. Alloys were simply being spawned, nine out of ten of them as like as two peas from the point of utility. Throughout it all there seemed nevertheless a more or less unconscious struggle to produce an ideal metal. They had as yet no metal which they could use for all purposes. Such an engineering metal must cast and forge easily and surely; rub on another piece of it without giving trouble; have a negligible coefficient of expansion with heat; be easily machinable; permit a working tensile stress of at least 20 tons per square inch.

THE complete elimination of unsightly air ducts is, says the *Electrical World*, accomplished in the new Fifteenth-street sub-station of the Union Electric Light and Power Company by the use of a "reversed" system of ventilation. The air moves opposite to natural circulation, the heated air being drawn down into the basement and the intake entering the main room above. This has the advantage of cooling the main room in summer, which adds greatly to the comfort and efficiency of men in the station. The air intakes are provided with doors which may be partly closed in winter for reducing the amount of cold air drawn into the station and damper doors in the discharge stack may be opened to permit re-circulating some of the heated air.

CONSIDERABLE research has been carried out at the Imperial College of Science upon the properties of lubricating oils for aircraft work. One of the first things which it has been shown must be done was to control the rate of oxidation of lubricating oils. These researches have shown that the addition of a small quantity of aniline completely stops oxidation under certain conditions, and thus there is opened up the prospect of controlling the oxidation of lubricating oils by the addition of small quantities of synthetic chemical compounds. Again, it has, according to Mr. H. T. Tizard, been shown by this research that lubricating oil in the presence of iron consumes oxygen at a much greater rate than in the presence of tin. The latter, indeed, actually inhibits the rate of oxidation.

SOME of the less common applications of electricity were dealt with by Mr. D. H. Bishop, engineer of the Dundee Corporation electricity department, in his inaugural address as Chairman of the Scottish Centre of the Institution of Electrical Engineers at Glasgow. He described the methods by which electricity can be used to measure the purity of water or judge the seasoning of wood. He also dealt in detail with the electrical methods employed for measuring small distances, such as are required in gauging and for ascertaining small movements caused by machinery in motion, even although the movement was no more than the thickness of a cigarette paper. In conclusion, Mr. Bishop outlined the X-ray examination of metal structures and the use of photo-electric cells for controlling machinery and as applied to the talking film and the timing of races.

IN a paper by Mr. L. M. Myers before the Television Society recently, some details were given of how it is possible to dispense with the Nicol cell polariser and use instead a simple piece of spar cemented to a glass prism. The prismatic angles of the glass and spar in the polariser are so arranged as to produce two distinct images of the arc crater at a distance apart in the focal plane equal to their diameter. When the objective is correctly set the two images are not distinguishable from one another; only the aperture is focused on the screen, but if the objective is displaced a distance equal to the axial distances between the aperture and the crater images, then the illumination of the aperture is due to both the ordinary and extraordinary rays. The result of this new optical arrangement is a picture 50 per cent. brighter than that obtainable with a Nicol rhomb (as determined by photometric comparison of the actual illumination of the spot on the screen). It is necessary to employ a special form of mirror-drum scanning, which is being developed in the Wilson Laboratory.

Miscellanea.

IT is reported that during fuel consumption trials the new Italian liner "Conte di Savoia" (48,000 tons) averaged 25·75 knots.

IT is said that an electric accumulator industry with a capital of £1,000,000 is being formed in this country. The accumulator will be of the lead plate type.

THE Limerick Harbour Board has provisionally accepted a tender at £72,991 by Messrs. John Kenny and Sons, Limerick and Dublin, for an extension to the floating dock.

THE Norsk Hydro Company is to erect a soda ash factory in Heron, Norway. It will have a capacity of 18,000 tons of soda ash, and will later also make caustic soda.

THE Salvage Association states that the contractors have definitely decided not to attempt further recovery of metal from the sunken liner "Egypt" during the present season.

ALL deposits of gold, copper, antimony, mercury, aluminium, phosphates, nitrates, coal, platinum, iron, and bismuth in Mexico are now, according to a presidential decree, nationalised.

THE construction of the San Francisco-Oakland Bay Bridge is to be commenced shortly. The work includes two 2310ft. suspension spans, a 500ft. tunnel through Yerba Buena Island, and a 1400ft. cantilever span, aggregating a total length of 7½ miles.

A TELESCOPIC travelling mooring mast for airships has been installed at Lakehurst, U.S.A. It is capable of mooring an airship at a maximum height of 160ft. above ground and of withstanding side pulls of 1000 lb. fully extended and 60,000 lb. when telescoped. It exerts a draw-bar pull of 57,000 lb.

OF the total of about 3,844,000 tons of gold and silver ores produced in the United States in 1930, more than 3,272,000 tons were treated at gold and silver mills using amalgamation or cyanidation. A large part of the remainder was sent to smelters as fluxing material, and the balance (283,053 tons) was treated at concentration plants.

ACCORDING to the September issue of the *Journal des Electriciens*, a clock which speaks the hours is to be installed shortly at the Paris Observatory and telephone subscribers, in Paris and elsewhere in France will be able to hear the exact time by ringing up the Observatory. It announces the time every ten seconds in a clear voice, gives the hour, the minute, and the second, and a special tick proclaims the completed minute.

IN this country, according to Mr. E. W. Smith, in a paper on "Refuse Disposal," the calorific value of refuse is rather higher in winter than in summer. In southern towns and in agricultural districts the net calorific values in summer and winter are of the order of 3000 and 4000 B.Th.U. per pound respectively, whereas in the neighbourhood of the coalfields the corresponding figures may reach 4000 and 5000 B.Th.U. per pound or more.

BY means of joint experiments on the part of officials of the Bradford Corporation Sewage Department and the City Gas Department, it has been found, states the *Gas Journal*, that, by certain alterations to plant at the sewage works at Esholt, the vast stocks of grease accumulating there can be made to produce an oil which will serve in place of paraffin for enriching the water gas manufactured by the Gas Department. The latter has placed an order for 400 tons of the grease.

AT the opening of the new laboratories of the Cardiff Gas Company, Dr. C. M. Walter, of Birmingham, stated that his experiments at Birmingham revealed that compressed coal gas gave 10 per cent. greater power than petrol, and was marketable at a cost which could compete with petrol retailed at 7¼d. a gallon. Most of the difficulties of compressing gas had been solved, and the experiments on internal combustion engines finished last week in results which were eminently satisfactory.

NEW large coal deposits are reported to have been discovered by Russian Government prospectors in the Kabardino-Balkaria district of the Northern Caucasus. The deposits extend from the left bank of the river Don eastward to the Volga. They are very extensive; one section at Gukov is estimated to contain 1000 million tons of anthracite. There is also an undetermined amount of anthracite in the Nesvetayev and Grushev districts, and coking coal in the Gundorov and Belo-Kalitven districts.

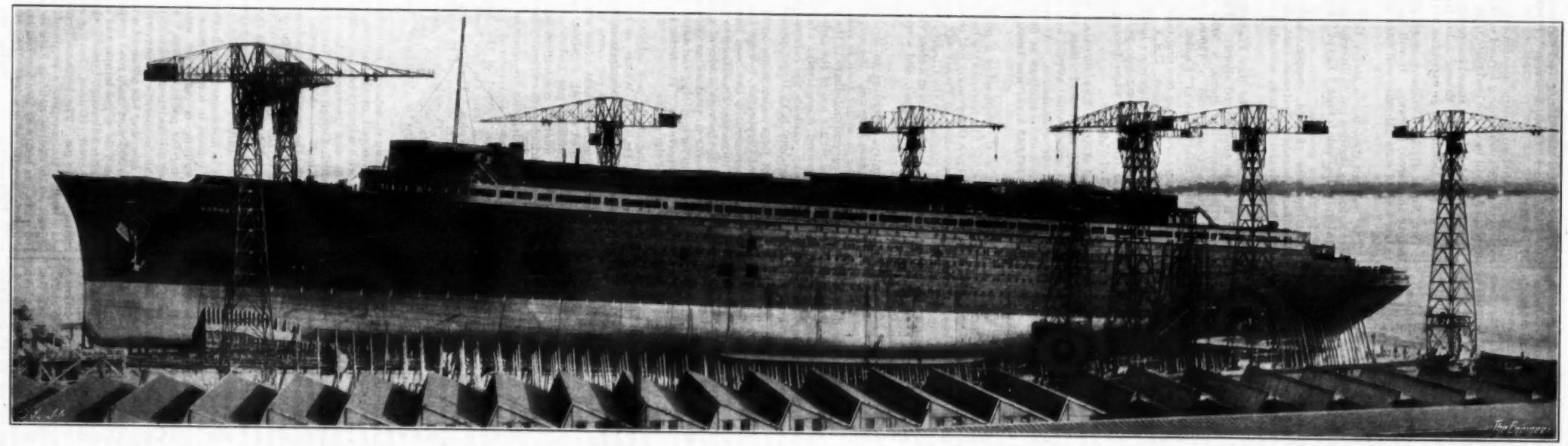
A LARGE and up-to-date rice mill is to be erected on the Thames. The object of the owners, who will work in conjunction with a group of rice millers in Burma, is to secure for the rice growers of the Empire the virtual monopoly which foreign rices have hitherto enjoyed in the United Kingdom. A site for the new mill has been fixed upon, and the erection of machinery has been put in hand, says the *Chemical Trade Journal*. It is hoped that the products of the mill will be on the market by the middle of next February, and that the mill with its distributing organisation will give a substantial amount of employment to British labour.

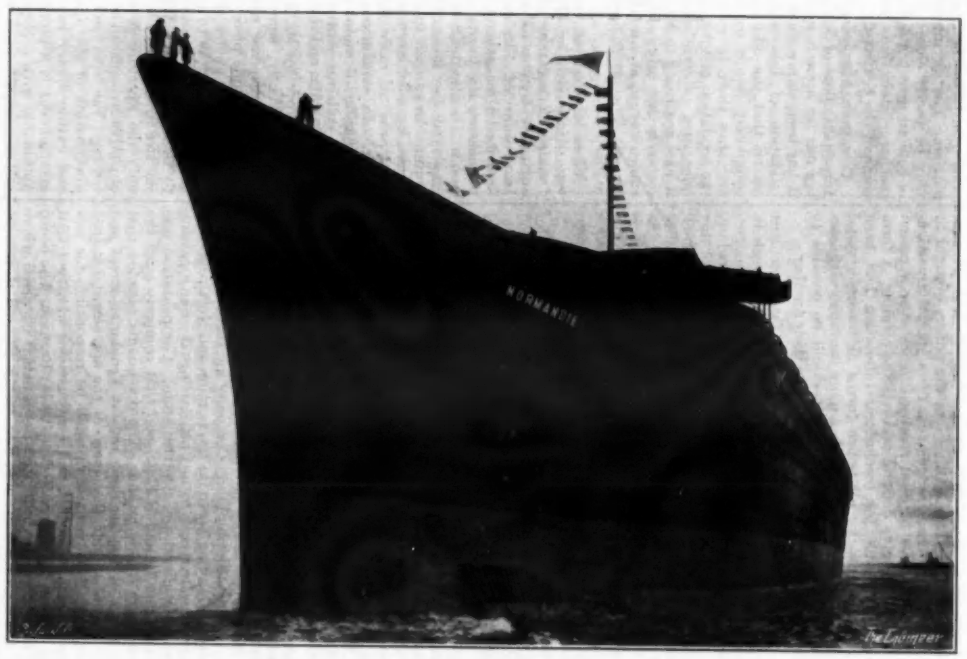
REFERRING to a statement by the City Electrical Engineer of Hull, quoted in a recent issue of THE ENGINEER, that "gas lighting is definitely more expensive than electric lighting for public services," the Gas Light and Coke Company directs our attention to the recent decisions of several public authorities to convert their lighting back to gas. The company has obtained a ten years' contract to replace the 500-watt main road lamps in the Uxbridge-road at Acton Vale to gas lamps, and a seven years' contract with Hendon Borough Council, the electric lamps in the Edgware-road, Hendon, having already been converted back to gas. The Feltham Urban District Council has accepted the company's proposal for seven years to convert all its electric lighting back to gas. An order for 106 extra gas lamps at Benfleet has been gained in direct competition with electricity. The cheapness of gas for public lighting is proved by the fact that in 318 towns and cities of England and Wales, four-fifths of the street lighting is by gas.

THE FRENCH LINER NORMANDIE

SOCIETE DES CHANTIER ET ATELIERS DE SAINT NAZAIRE (PENHOET), BUILDERS

(*For description see page 477*).





The Engineer

NOVEMBER 11, 1932.

VOL. CLIV. No. 4009

Contents.

THE ENGINEER, November 11th, 1932. PAGE

A SEVEN-DAY JOURNAL 473
PRECISION GRINDING MACHINES. No. VIII. (Illus.) 475
SALVAGE OF SUBMARINE "M 2" 475
INDUSTRIAL ECONOMICS IN AMERICA 476
THE FRENCH LINER "NORMANDIE." (Illus.) 477
MARINE MOTOR SHOW. (Illus.) 477
ARTICULATED EXPRESS LOCOMOTIVE FOR ALGERIA. (Illus.) 480
SOME NEW COLD SAWING MACHINES. (Illus.) 481
SOUTH AFRICAN ENGINEERING NOTES 481
LETTERS TO THE EDITOR—
Stabilisation of Colloidal Coal in Fuel Oil 482
SIXTY YEARS AGO 482
ROUNDABOUT WORKING FOR RAILWAY TRAINS 482
RAILWAY AND ROAD MATTERS 483
NOTES AND MEMORANDA 483
MISCELLANEA 483
LEADING ARTICLES—
Trade with New Zealand 485
Modern Physics and the Engineer 485
ATOMIC PROJECTILES AND THEIR APPLICATIONS 486
LITERATURE—BOOKS RECEIVED 487
A VISIT TO THE ENGLISH ELECTRIC COMPANY'S STAFFORD WORKS. (Illus.) 487
A NEW BOILER WATER LEVEL INDICATOR. (Illus.) 490
AN INTERESTING DREDGER. (Illus.) 490
SHAFT SINKING BY THE FREEZING PROCESS. (Illus.) 491
WOVEN BELTING 491
SEVEN CUBIC FEET CONCRETE MIXER. (Illus.) 491
PERICENTRIC HELICAL-GEARED MOTOR. (Illus.) 491
CANADIAN ENGINEERING NEWS 491
DYNAMIC EFFECTS IN RAILWAY BRIDGES. (Illus.) 492
PROVINCIAL LETTERS—
The Midlands and Staffordshire 493
Lancashire 493
Sheffield 494
North of England 494
Scotland 495
Wales and Adjoining Counties 495
EDUCATIONAL INTELLIGENCE 495
PERSONAL AND BUSINESS ANNOUNCEMENTS 495
CONTRACTS 495
CATALOGUES 495
CURRENT PRICES FOR METALS AND FUELS 496
FRENCH ENGINEERING NOTES 497
BRITISH PATENT SPECIFICATIONS. (Illus.) 497
FORTHCOMING ENGAGEMENTS 498

NOTICES TO READERS.

**** *If any Subscriber abroad should receive* THE ENGINEER *in an imperfect or mutilated condition, he will oblige by giving prompt information of the fact to the Publisher, with the name of the Agent through whom the paper is obtained. Such inconvenience, if suffered, can be remedied by obtaining the paper direct from this office.*

**** *For Subscription rates see page 2 of Advertisements.*

**** *All letters intended for insertion in* THE ENGINEER *or containing questions should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

**** *No undertaking can be given to return drawings or manuscripts; correspondents are therefore requested to keep copies.*

TRADE WITH NEW ZEALAND.

ON the same day that the details of the Ottawa agreements were made public, Mr. L. A. Paish, H.M. Trade Commissioner in New Zealand, gave at a luncheon of the British Engineers' Association an address which should be read not only by engineers, to whom it was particularly addressed, but by all who are endeavouring to gain clear views through the intricacies of Imperial trade. The address, we are happy to say, has now been printed in full in the current issue of the Association's Bulletin, and we have little doubt that copies of it may be obtained by *bonâ fide* inquirers from the Secretary, at 32, Victoria-street. Many people have at some time entertained the belief that the British Empire could be a self-satisfying unity, able to supply not only all its material wants, but all its financial and industrial requirements without any dependence on foreign trade. Whether that ideal could ever be satisfied by the ability of the Empire to consume all that it can produce, and to produce all that it needs, is a debatable question. But assuming that an affirmative answer could be given, considerable doubt would still remain that the self-isolation even of a community of nations could be maintained against external pressure. It will be recalled that not so many years ago the United States of America cherished the same idea. It has long since gone by the board and America is not only a keen seeker of foreign trade, but now takes part in international politics.

Mr. Paish touches upon this problem, but it is rather to certain aspects of British-New Zealand trade, as presented by him, that we desire at the moment to direct attention. He reminds us that since New Zealand is essentially a pastoral and agricultural country, she is not a large purchaser of machinery, yet last year, one of great depression, she imported machinery to the value of two and a-quarter million pounds, 54 per cent. of which came to this country, and the rest mainly to Canada and the United States. We have no reason to quarrel with the share which Canada enjoyed, and, indeed, may congratulate ourselves on our own large proportion. But this satisfaction is tempered by consideration of the reasons why our share was not even greater. "It is not," said Mr. Paish, "that your goods are unsuitable, but that the New Zealander really believes that the goods, particularly from America, are the goods suitable for his market and that he cannot get corresponding goods at anything like the same quality and price from this country." Whilst we must be grateful to Mr. Paish for his assurance that our goods are not unsuitable, we hesitate to accept it with complete conviction. It is rather hard to believe that if what we can offer is as attractive in all respects as what America can offer, the cause of our failure is, as he avers, entirely due to less effective publicity and selling methods. Mr. Paish himself provides us with an example to the contrary. He tells us that in 1929, 82 per cent. of the motor cars in New Zealand came from America, and only 17·4 per cent. from this country. In a few years the position was reversed, and now Great Britain provides over 70 per cent. of the trade in motor cars and America no more than 28 per cent. The motor cycle gives an even more striking example. At one time 64 per cent. of the imports were American; nowadays, practically the whole trade, 99 per cent., is English. Those wonderful results have been attained, particularly in the case of cars, because the British product suits the New Zealand conditions better than the American. When, in face of what has been attained in these directions, Mr. Paish tells us that we cannot sell vacuum cleaners, cream separators, wireless sets, harvesting machinery, &c., in New Zealand, we are strongly tempted to think that there must be more in our failure to do so than poor publicity and bad selling. Indeed, Mr. Paish admits as much in a later sentence. After showing that as far as 40 per cent. of New Zealand imports are concerned, British goods enjoyed, in 1930, a preference of 24½ per cent. *ad valorem*, he remarks: "If business cannot be obtained with this preference, it would seem that there is something inherent in the foreign goods which is not in the British goods, and that there is something wrong with British manufactures." Continuing, he adds: "Last year in the machinery section, foreign trade amounted to some £800,000, and 83 per cent. of this was in goods in which the United Kingdom manufacturer had a preference of 24½ per cent. or more. Is there not," he asks, "something wrong that you cannot get that business in the engineering industry in the most patriotic country in the world?" That is a question which we profoundly hope will be carefully pondered. Cheap labour does not appear in this case, for the competitive goods came from the United States and Germany. Clearly, there is something more in it; something that will bear investigation. It should not be difficult to discover what merits there are in American and German machines which enables them to compete successfully against so high a protective duty, and once they are discovered we do not for a moment believe that British engineers will be incapable of providing them. Let us remember the example of motor cars and motor bicycles and, we may add, of heavy machinery in which the British position is unchallenged. It may be that forces which manufacturers can do little to control are at work. The remoteness of the Antipodes cannot be without some effect; the size of the market may offer insufficient temptation; even the rigid adherence to standards may fight against us. But if Great Britain really desires the trade, it can, we are certain, be won, and if she does not want it, anything that New Zealand could do further by preferential tariffs will not make it fall into her lap.

Towards the end of his address, Mr. Paish reverts to his contention that bad salesmanship is the prime cause why the proportion of New Zealand trade is not as high as it might be. But he also gives reasons why the volume of that trade—not the ratios enjoyed by several countries—is lower than it ought to be. "I do want to impress upon you," he says, "that, notwithstanding the Ottawa Conference, you are not going to get much foreign trade out of New Zealand by tariff adjustments. There is only one way in which you can increase the sale of British goods in New Zealand. You have got to increase the capacity of the New Zealander to buy. You have got to increase the value of his export trade, and that can only be done by increasing the price of his products which are sold to the extent of 88 per cent. in this market." In those words Mr. Paish said what so many economists are now saying, that trade cannot improve until prices begin to rise. We do not propose to discuss at the end of an article an apparent paradox, but we must note with pleasure Mr. Paish's assurance that if prices harden, as they are beginning to do, some 60 to 70 per cent. of the increased trade will be returned to this country in the shape of orders from New Zealand. He is confident that the tide has turned in New Zealand, and that her purchasing power is already on the increase. We need scarcely express the hope that British engineers will take advantage of the improvement by a careful study of the suitability of their goods for that market, and the effectiveness of their publicity and selling organisations.

Modern Physics and the Engineer.

IF a physicist or chemist of the Victorian age, revisiting the scenes of his worldly studies, had joined the audience which assembled last Friday to hear Lord Rutherford's Hawksley lecture on "Atomic Projectiles and their Applications," he would, it is very certain, have experienced an uninterrupted succession of surprises and shocks. Physics and chemistry, as he left them, were sciences which seemed to be definitely established on the unshakable basis of a few great fundamental truths, the laws of the conservation of matter and of energy, the Newtonian laws of motion, the existence of the atom as the ultimate particle of matter, and of eighty or ninety different elements which could not, by any possible process, be transmuted from one kind into another. Within the framework of those truths, somewhat rigid though it might be, he was prepared to explain all known natural phenomena or to seek the explanation of any new fact that might be revealed to him. His faith in his system of mechanics or of chemistry was complete. More readily would he have denied the existence of all objective phenomena than have doubted the validity of the fundamental beliefs in the light of which he and his fellows interpreted them. Everything seemed to have been fixed in its place so decisively that any expression reflecting on the permanency of the structure would have been regarded as heretical. Yet the lapse of but one or two generations has proved sufficient, not merely to throw doubts on the old beliefs, but to lead to some being definitely discarded as untrue and to others being modified, twisted about, and juggled with until they have become scarcely recognisable for what they were. In the welter of the revolution which has been wrought modern science, it might seem, takes delight in riding rough-shod over the most profound beliefs of former times and almost appears determined to set itself free from the restraint of natural laws. Whither is it all leading? Many who take an intelligent interest rather than an active part in the developments of physical science would be glad to hear that with the overturning of the old idols modern physicists feel completely assured that they are at last on the road to truth and that they are, with certainty, leading us out of the wilderness and not into one.

Much is heard concerning the progress of modern physics. We listened in vain to hear Lord Rutherford telling us something about its fundamental difficulties. Having got rid of the luminiferous ether because of the intolerable complexities which its supposed existence entailed, has the physicist reached the open sea and plain sailing? Is everything now working out consistently and smoothly without absurd contradictions and without the necessity for doing violence either to mathematics or common sense? Lacking authoritative pronouncements on these points, we can form an opinion on them only from our own interpretation of the statements made to us by the physicists. From the outside there is little to be gathered encouraging us to believe that modern physics contains the elements of a consistent and harmonious conception of the universe. It very definitely possesses two voices, and it does not appear to be quite certain when to use one and when to use the other. If it suits the circumstances of the moment it will make use of Newton's classical system of dynamics. At other times it will adhere to Einstein and relativity and at yet others it will apparently speak in terms of both simultaneously. This practice may be defended on the ground that the Newtonian philosophy gives results which are sufficiently accurate when velocities very much less than the velocity of light are involved in our calculations. Nevertheless, the test of any philosophy is the manner in which it fits the observed facts and is analogous to fitting an empirical formula to a curve of unknown equation. It is quite a common experience to find that a formula can be devised to suit one end of a given curve up to a point and another quite different formula to suit the other end. The deduction to be drawn in such an event is that either the curve

is discontinuous or that its true formula is neither that deduced for one end nor that deduced for the other, but some unknown expression covering both ends and the middle as well. The Newtonian philosophy fits the low-velocity end of the range of natural philosophy. Relativity has been proved to fit one or two points at the higher end. Why are the majority of physicists so certain that the curve is continuous and that the relativity formula is fundamentally true throughout its whole length? On this major subject we would like to have our doubts resolved. There are in addition many other aspects of modern physics which seem to require explanation before they can carry conviction to the ordinary person. Twenty or thirty years ago any student of chemistry who had dared to write such an equation as $N+He=O+H$ would certainly have failed to please his instructor or satisfy his examiners. Yet on Friday evening it was quite calmly written down on the blackboard by the past-President of the Royal Society as an expression of a positive fact, the transmutation of nitrogen into oxygen and hydrogen by bombardment with alpha particles or atoms of helium. We are quite prepared to adapt our minds to the transmutation of the elements, but the process by which it occurs requires more explanation than Lord Rutherford had time to give us. In order that the equation set forth above may be satisfied it is necessary to assume that the atomic weight of the oxygen produced is 17. A similar violation of familiar figures is involved in other cognate reactions. Nitrogen bombarded with neutron particles produces, it seems, boron with an atomic weight of 11 and oxygen similarly treated produces carbon with an atomic weight of 13. The inculcated belief that an element with an atomic weight other than 16 is not oxygen, and other than 12 is not carbon, will die hard. Yet it is essential in the new physics to have faith in the existence of isotopes of the elements; that is to say, of atoms which, while they possess different atomic weights, have chemical properties so similar that the ordinary methods of separation based on chemical affinity are powerless to distinguish them from one another.

If modern physics is to maintain any connection with practical life, if it is to avoid isolating itself as a department of science dealing purely with abstractions and speculations, it is essential that it should explain itself in terms comprehensible by the ordinary electrical and mechanical engineer. It is they who would be called upon to apply whatever discoveries it might make. For the moment it is shrouded in a mist of unreality and detachment, but as engineers we must recognise that it is working along lines which may in the not distant future profoundly affect our practical activities and their scientific basis. We cannot afford to remain completely indifferent to the subjects which it is studying and the results which it is claiming to obtain. We are, or should be, for example, keenly interested in learning all it has to teach us concerning the energy liberated by the disintegration of the atom, even although, as now seems to be proved, the amount of that energy is not greater than the total amount of energy expended on effecting the disintegration. We are anxious, too, to make ourselves familiar with all it has to teach us concerning the relationship between mass and velocity, for it is fairly obvious that if mass is not constant, but is dependent upon velocity, the engineer may one day find himself at the gateway to an entirely new world. For the time being modern physics seems still to be struggling to find its feet. No one can feel safe in prophesying to what goal it will lead. Only this is certain: if it succeeds in proving that it is following the path of truth it will involve us in a total change of our attitude towards natural phenomena and the forces behind them. We may perhaps console ourselves with the thought that the revolution which is now in progress will not affect our work as engineers in so far that it relates to physics applied to masses and speeds far beyond those with which we normally deal in our practical activities. It would be too bold, however, to assert that it will always be so. Already Lord Rutherford and his fellow-investigators are using equipment of an engineering order and are realising therein for experimental purposes the production of sub-atomic particles moving with velocities approaching the speed of light. Very little imagination is required to foresee the possibility that the apparatus which is now purely of a laboratory interest may yet enter directly into the everyday work of the engineer, the chemist, and the metallurgist.

Atomic Projectiles and their Applications.*

By Professor Lord RUTHERFORD, O.M., M.A., LL.D., D.Sc., F.R.S.

It is of interest to consider the maximum speeds that can be communicated to matter in bulk and to compare them with the speed of the atomic projectiles used every day by the physicist in his experiments. The maximum velocity that can be communicated to the rim of a suitably shaped rotating steel disc is controlled by the tensile strength of the material and does not exceed at the best 2 miles per second. The peripheral speeds used in practice are much lower. For example, if it is to be efficient, the tip of an aeroplane screw should not travel faster than the velocity of sound, or about one-fifth of a mile per second.

We shall next consider the velocities that can be communicated to matter by the use of explosives. The maximum speed of the rifle bullet under the best conditions is about half a mile per second, while the shell from "Big Bertha" which bombarded Paris had a maximum range of about 80 miles and a muzzle velocity of about 1 mile per second. No doubt the speed which can be communicated to projectiles by such methods will be exceeded in the future, and much higher speeds may be ultimately obtained by the development of a rocket type of apparatus. We may take it, however, that at present the maximum velocity that can be communicated to matter in bulk is not more than 2 miles per second. It is of interest to note that this is of the same order of magnitude as the average speed of molecules of gases under ordinary conditions. The average velocity of agitation of the molecules of oxygen gas at normal temperature is about ½ mile per second and of hydrogen molecules about 1 mile per second. The molecular speed varies as the square root of the absolute temperature, so that even at a temperature of 7000 deg. Cent. the average speed for an undissociated gas only increases by a factor of five times. No doubt if we were able to pass to the interior of a hot star where the temperature may be of the order of 100 million degrees, the average velocity of agitation of the hydrogen atoms reaches high values, of the order of 1000 miles a second, and thus becomes comparable with the velocities acquired by charged atoms of hydrogen in an ordinary discharge tube. While in our normal experience we rarely obtain or observe velocities of matter greater than a mile per second, yet occasionally we have evidence of the destructive effects of large masses of matter moving at much higher speeds. For example, it is estimated that the great Siberian meteorite which fell in 1908 had a mass of about 100 tons and reached the earth with a speed of 40 to 50 miles a second.

Even if large sources of energy are available, our experience has shown that it will be difficult to set matter in motion with a speed of more than a few miles per second. Yet if we pass from matter in bulk to the individual atoms of matter, the situation is very different, for simple methods have been developed in the laboratory to produce atomic projectiles moving with enormous speed. This has depended on producing charged atoms or molecules of matter by means of electrical discharges or other appropriate agencies and accelerating them by strong electric fields in a good vacuum.

As you know, the passage of an electric discharge from an induction coil through a gas at low pressure—of the order of 1/100 mm. of mercury—leads to the liberation of electrons and the production of charged atoms and sometimes charged complex molecules which acquire energy of motion in their passage through the electric field. In this way we can obtain a copious supply of fast electrons and swiftly moving atoms of matter. The velocity acquired for a given charge varies as the square root of the voltage applied, and inversely as the square root of the mass of the particle. In this way it can be shown that an electron moving freely from rest through a difference of potential of 1 volt acquires the great velocity of 590 kiloms. per second. Since the charge carried by the atom of hydrogen is numerically equal to that of the electron, but its mass is 1840 times greater, the velocity acquired by the hydrogen atom under the same conditions is 13·8 kiloms. per second. For a singly charged atom of mercury of mass 200 times that of hydrogen the speed is 1 kilom. per second. If the particles fall through a difference of potential of 100 volts instead of 1, the speeds are all increased by a factor of 10.

When the speed of the particle becomes comparable with that of light, we have to take into account the change of mass of the particle with speed.

For the study of many physical problems, streams of charged particles of appropriate speed, generally produced by the acceleration of the particles in an electric field, are often required. For brevity it is very convenient, for example, to speak of a 1000-volt electron or proton or other charged particle, meaning thereby that the particle has the speed and energy equal to that gained in passing freely between two points differing in potential by 1000 volts. Similarly, it is convenient to express the energy of the electron or other particle in terms of electron-volts. Methods have been devised in the laboratory to produce charged particles varying in energy between a fraction of a volt and 1 million volts. By the use of the swift α and β particles spontaneously expelled from radio-active substances, this range of energy is increased to 10 million electron-volts, while we have direct evidence that ultra-penetrating radiation in our atmosphere gives rise to particles of energy reaching as high as 1000 million electron-volts.

Numerous experiments are in progress throughout the world to develop methods of production of high-speed particles for experimental purposes. Coolidge was one of the first workers in this field and succeeded in obtaining a stream of swift electrons of energy approaching 1 million volts. Subsequent experimenters have mainly concentrated on methods of obtaining swift protons or other atoms to be used in investigations on the transmutation of matter by atomic bombardment. Various methods have been used to obtain the requisite high potentials, including induction coils, transformers, Tesla coils, and special types of electro-static machines. There is no insuperable difficulty in devising tubes to withstand an accelerating voltage of several million volts, but the size of the apparatus and the size of the laboratory to contain it, not to mention the cost, increase rapidly with the voltage.

It would be a great advantage for many investigations to obtain streams of atoms of energy as high as 10 or 20 million electron-volts. For this reason, experiments have been made to devise methods of accelerating atoms which do not involve the almost brutal method of generating very high potentials to be applied directly to a vacuum tube. A very interesting method has been tried by Lawrence and Livingston, of the University of California, who state that they have been able to obtain a stream of protons of energy as high as 1,200,000 volts by the use of a voitage as low as 4000 volts. They consider that it should be possible by a development of their method to obtain a reasonable stream of protons of energy as high as 10 or 20 million volts.

Applications.—The study of the effects of collision of atomic projectiles with the atoms or molecules in their path has proved of great importance to the advance of physics in many directions. Time does not allow me to refer more than briefly to the more important results obtained by these methods. If a stream of electrons of a few volts energy passes into a gas at low pressure, there are occasional collisions of the electrons with the atoms or molecules which are elastic in character. When the energy of the electrons exceeds a certain value, some of the collisions are inelastic and the colliding electron may lose part or the whole of its energy either in exciting the atom or in removing one of its outer electrons and thus ionising it. By the use of this general method, we have been able to determine the energy required to ionise the atoms or molecules, and to determine the energy required to excite the atom in order to emit some of its characteristic radiations. Experiments of this kind have proved of great importance in giving us information as to the structure of the outer atom and particularly of the values of the energy levels which are so closely connected with the explanation of the complicated light and X-ray spectra of the elements.

Atomic Collisions.—On modern views, all the atoms of the elements have a similar type of electrical structure consisting of a positively charged nucleus of minute dimensions surrounded at a distance by a distribution of electrons in rapid motion. Practically all the mass of the atom resides in this minute nucleus and the ordinary physical and chemical properties of the atom apart from its mass are controlled by the magnitude of the nuclear charge. The swift α-particles which are expelled from radioactive substances are known to be helium nuclei of mass 4, and may escape with an energy of motion as high as 10 million electron-volts. Such swift α-particles are able to pass freely through the outer electronic structure of the atom, and in general the tracks of these particles through a gas are nearly straight. Occasionally, however, one of these particles approaches so closely to the nucleus of an atom in its path that it comes into violent collision with it and may be deflected through a large angle. On account of the minute dimensions of atomic nuclei such encounters are rare, and it may be that only one α-particle in 1000 or 10,000 may suffer a large deflection in its path through air. The detailed study of these rare encounters has given us information of fundamental importance.

It must be borne in mind that these collisions must not be regarded in the ordinary mechanical sense. The actual nuclei never come in contact in the collision, but the deflections are due to the intense electrostatic forces between the colliding nuclei. Considering the minute masses of the nuclei involved, these collisions are of enormous intensity. For example, in a head-on collision of a swift α-particle with a heavy nucleus in which the α-particle is deflected backwards, it can be calculated that the maximum force of repulsion between the nuclei, notwithstanding their minute masses, corresponds to several pounds in weight.

The Transmutation of Matter.—The development of chemistry during the last century showed that the atoms of the elements appeared to be indestructible

* The Institution of Mechanical Engineers, the Nineteenth Thomas Hawksley Lecture, November 4th.—Abstract.

entities, for they were not affected by the most drastic physical and chemical agencies. A definite attack on the problem of transmutation had to await a clearer understanding of the structure of the atom and the development of methods for detecting individual atoms in swift movement. The discovery of radioactivity in 1896 provided the first clue to the elucidation of the problem of transmutation. The proof by Rutherford and Soddy that the heavy radioactive elements were undergoing spontaneous transformation was a great step in advance and revived the dormant interest in this age-old problem. The study of these uncontrollable transformations, accompanied by corpuscular radiations of great individual intensity, gave us for the first time some idea of the powerful forces that must exist within the atom. The α-particles emitted from radioactive bodies are the most energetic projectiles known to science, if we except the very swift particles accompanying the ultra-penetrating rays in our atmosphere. We have seen that the nuclear structure of all atoms was first demonstrated by studying the scattering of α-particles.

In 1919, I made some experiments to test whether the nuclei of light elements could be altered by bombardment with the energetic α-particle. It seemed probable that in a direct collision, the α-particle must approach very closely to the nucleus of a light atom and might even enter its structure. When a powerful stream of α-particles was passed through nitrogen gas, a number of penetrating particles was observed by the scintillation method. These were found to be hydrogen nuclei—protons travelling at high speed. Under the experimental conditions the appearance of these swift protons could only be accounted for on the assumption that they were ejected from the nitrogen nuclei as a result of close collision with the α-particles. In this way, we obtained for the first time definite evidence of the transmutation of an element by artificial methods. On account of the minute dimensions of the nuclei, these disintegrating collisions are very rare, for only one proton is observed for about 100,000 incident α-particles. Later, Blackett and Harkins were able to obtain direct photographic evidence by the expansion method of a few of these disintegrating collisions, and showed that the bombarding α-particle was actually captured by the nucleus, resulting in the expulsion of a swift proton. The nature of this transformation is now clear. The nitrogen nucleus of charge 7 and mass 14, captures the α-particle of mass 4 and charge 2, while a proton of mass 1 and charge 1 is expelled. The resulting nucleus thus has a charge 8 and a mass 17, or, in other words, is an isotope of oxygen of mass 17. Long after these experiments, ordinary oxygen was found to contain a small quantity of an isotope of mass 17, showing that the product of transmutation of nitrogen is a stable element. In conjunction with Dr. Chadwick, a number of other light elements were found to be transformed by α-ray bombardment. In all cases protons were ejected, but the number and speed of the protons varied for the different elements. In the case of aluminium, some of the protons were ejected with an exceptionally high velocity and had an energy even greater than that of the bombarding α-particle. It appears probable that in all these cases of transmutation, the α-particle is captured by the nucleus and a proton ejected, so that the process leads to the formation of an element of mass 3 units greater and charge 1 unit higher than the bombarded nucleus.

Discovery of the Neutron.—Another unexpected type of transformation has been disclosed by these experiments on artificial disintegration by α-particles. When the light element beryllium is bombarded by α-particles, no protons are emitted, but Bothe observed some years ago that a very penetrating type of radiation appeared. This was initially supposed to be of the γ-ray type, but a more detailed investigation by Monsieur and Madame Curie-Joliot disclosed a very surprising property of this radiation. When this radiation from beryllium passed through material containing hydrogen, it led to the appearance of swift protons. Chadwick carried out further experiments by counting methods and found that the radiation was able to set the nucleus of all light elements in rapid motion. He concluded that the radiation was not of the γ-ray type at all, but consisted of a flight of material particles, or "neutrons," as he termed them. The neutron is supposed to consist of a very close combination of a proton and an electron which behaves as a unit, of charge zero and mass nearly equal to 1. The swift neutron occasionally collided with the nuclei in its path and set them in rapid motion. The idea of the possible existence of such neutrons had been suggested by me in 1921, and various experiments had been made to detect them in electric discharges but without success.

In the light of these results, it seems clear that the reaction which leads to the expulsion of a neutron from a beryllium nucleus may be explained in the following way. The α-particle is captured by the beryllium nucleus while a neutron is liberated, expressed by the relation $Be^9 + He^4 = C^{12} +$ "neutron," or, in other words, the carbon isotope of mass 12 is produced as a result of the transformation which gives rise to the neutron.

On this and other data, Chadwick showed that the mass of the neutron is 1·0065, somewhat less than the mass of the hydrogen atom 1·0077. This indicates, as we should expect, that the electron in the neutron is more tightly bound than in the ordinary hydrogen atom. Similarly, neutrons have been found to be liberated when boron is bombarded by α-particles.

Literature.

The Problem of Incentives in Industry. By G. H. Miles, D.Sc. London: Sir Isaac Pitman and Sons, Ltd. 1932. 58 pages. Price 3s. 6d. net.

The author of this little book considers that the root problem of industry at the present day is to supply adequate incentives, so that the maximum energy of each worker, from the highest to the lowest, may be so directed that the best interest of the firm will be served. The subject is divided into three sections, the first dealing with fear and financial incentives, the second with those of a non-financial character, and the third with those that concern the management.

We fully agree that the incentive of fear is of very doubtful value as a means of obtaining better work. It has been exploited unduly in the past, has promoted antagonism between employer and employed, and has probably done more harm to the loyal worker than good to the indifferent. In any case, we feel it should be a last resort. Financial incentives, and the many bonus, piecework, and profit-sharing schemes involved have been described and discussed almost *ad nauseam*, and we are accordingly glad to notice that Dr. Miles contents himself with a brief survey of the position.

It is when we consider the non-financial incentives that we enter a very fruitful field for exploration. Steps that can be taken to develop the interest of the worker, his loyalty, his knowledge, and his interest in the firm, so that eventually his pride in the efficiency of its products is assured, all warrant the closest attention, and we welcome the suggestions made to this end. We are told that "a man gets the kind of servants he deserves; a firm gets the kind of worker it encourages," and we believe that even in the days of big organisations much can be done to foster *esprit de corps*, if only more attention were devoted to friendly intercourse between the different ranks in the undertaking. That harmonious co-operation can be attained has been demonstrated conclusively in a practical manner, and by it the personality and character of the worker have been developed, and efficiency increased, but it has involved a careful study of the psychology of the worker coupled with the total abolition of the spirit of distrust, and a curbing of individual selfishness.

Too frequently it is almost regarded as an axiom that the problem of incentive is strictly confined to the wage earner, but the author takes exception to this, and proceeds in his third chapter to stress the importance of aiming at the development and encouragement of departmental heads, managers, and foremen. With the apparent diminution of responsibility that comes from functionalisation, and the trouble and dissatisfaction frequently incident to schemes of reorganisation, a definite loss of efficiency is too often experienced. A modern system of costing, if arbitrarily introduced, is prone to engender suspicion which may be fanned into active hostility, whereas if rightly handled it may greatly assist in determining powerful management incentives. We are in cordial agreement with Dr. Miles in his contention that new methods and ideas should be thoroughly explained to and understood by all concerned prior to their introduction. When he comes to the question of offering incentives to technical research, nobody is likely to cavil at his statement that "a qualified research worker who has had an expensive university training will often receive a much lower salary than the head of a small department"; but we should have welcomed some concrete proposals as to the incentives which might be offered to the scientist in industry, so that all might be agreed that he was receiving equitable treatment. In this, the author does not give us a lead.

Even if reading this book fails to produce generally the conviction that "the main purpose of industry is not . . . to make profits," it will undoubtedly have served a very useful purpose, but we confidently anticipate that it may go further and inspire the industrialist to aim at "the amelioration of the conditions of life of all classes" that come under his administration.

BOOKS RECEIVED.

Design of Steel Buildings. By H. O. Hauf. London: Chapman and Hall, Ltd., 11, Henrietta-street, W.C.2. Price 16s. 6d. net.

Strength of Materials. Third edition. By J. P. Knottcamp and A. C. Harper. London: Chapman and Hall, Ltd., 11, Henrietta-street, W.C.2. Price 10s. 6d. net.

International Handbook of the By-product Coking Industry. By Professor Dr. W. Gluud. English edition by C. M. Myers. London: Ernest Benn, Ltd., 154, Fleet-street, E.C.4. Price £4 4s. net.

Patents, Trade Marks and Designs: Their Commercial Aspect and Development. By C. W. Thomas. London: The Ocean Publishing Company, Ltd., 35, Great James-street, W.C.1. Price 4s. 6d. net.

A Visit to the English Electric Company's Stafford Works.

From Monday to Friday of last week visits were paid by engineers from various parts of the country to the Stafford Works of the English Electric Company, where, in addition to inspecting the shops, they were afforded an opportunity of studying the details of many of the company's products, which had been collected together to form a special exhibition. All who journeyed to Stafford were amply repaid for their trouble. Never has any firm brought a better or more up-to-date collection of electrical plant to the notice of visitors, or taken greater pains to explain the principles of things with which, perhaps, the average electrical engineer is at present none too familiar. Developments in various fields of electrical engineering are not always immediately appreciated or properly understood by all engaged in the industry. But demonstrations such as those that were given at the English Electric Company's works last week are a great help to engineers seeking enlightenment. For the most part inspections of electrical works do not arouse great enthusiasm in people who are frequently inspecting them. The manufacture of standard machines and apparatus does not prove very exciting to those familiar with the processes involved; but when a firm sets out to throw light on the methods of construction and possible applications of such modern things as rectifiers, a visit to its works is well worth while.

Rectifiers.

Although at one time it appeared that British electrical manufacturers were never going to interest themselves in metal-cased mercury arc rectifiers, at least four firms are now engaged in the business, and the English Electric Company is one of them. We give, in Fig. 1, a view of what is claimed to be the largest mercury arc rectifier built in this country. Of the various things exhibited, this rectifier probably claimed most attention. Its normal output is 2200 kW at 550 volts, and is intended for a three-phase, 50-cycle supply. At the normal load and voltage the current is 4000 ampères, but overloads of 5000 can be carried for fifteen minutes, and 10,000 ampères momentarily. At 800, 1600 and 3000 volts the rectifier is capable of giving 3200, 3200 and 3000 kW respectively, the corresponding ampères being 4000, 2000 and 1000. The maximum overload is 6000 kW. Glass bulb rectifiers—see Fig. 2—are also produced at the Stafford Works. The D.C. output of the equipment illustrated is 300 ampères at 220 volts, but the rectifier may also be worked at pressures up to 500 volts with a suitable transformer. The equipment is supplied complete with a regulating transformer designed for a voltage variation of ±10 per cent. It is well known that a great deal of research work has been done with a view to developing the principle of grid control, which offers the possibility of making a rectifier perform other duties besides that of converting A.C. to D.C., and one of the firms that has been engaged in that work is the English Electric Company. A section through a grid-controlled, 2500 kW rectifier for pressures up to 800 volts is given in Fig. 4, whilst the company's demonstration equipment for showing possible applications of grid-controlled rectifiers is illustrated in Fig. 5.

Grid Control Demonstrations.

Eight experiments designed to show the possibilities of grid-controlled rectifiers were made. Some of them were, perhaps, of greater theoretical interest than of immediate practical value, but in any case it is pretty certain that interesting rectifier developments will shortly be witnessed. In the first case it was shown that it is possible, by means of grids, in the neighbourhood of the anodes, to retard the ignition of the arc current by applying a grid potential which, at the required instant of ignition, changes rapidly from a negative to a positive value. When the arc has begun at any particular anode the grid can no longer influence or extinguish it, and the arc continues until the anode voltage falls to zero. If a negative potential is applied to the corresponding grid the arc discharge cannot take place, and, naturally, the rectifier will not supply current to the D.C. circuit. But if, on the other hand, a positive potential is applied to the grid, the corresponding anode can pass the arc current undisturbed during its positive half cycle of anode voltage. At *a* in Fig. 6 a six-phase rectifier is shown connected so as to supply a load of lamps. A grid is connected through a resistance R_1 to the negative pole of a battery giving about 300 volts and through a resistance R_2 and a switch to the positive pole, the mid point being connected to the cathode of the rectifier. Although not shown in the diagram, the remaining grids are similarly connected, and instead of six switches in the positive leads from the battery, there is a rotary distributor. Moreover, in practice the battery is replaced by a small copper oxide rectifier. If the distributor mechanism (represented by the switch) is adjusted so that no contact is made, the rectifier is unable to supply current, but on rotating the distributor through a small angle the circuit is made in one of the grid leads. Thus the grid receives a positive potential impulse and ignites the arc on the corresponding anode. On slowly rotating the distributor the anode arms light up in sequence in the manner characteristei of rectifier operation, and on rotating the distributor in the opposite direction the arc traverses the anodes in the reverse sequence.

Switching.

If at any instant all the grids are made negative the anode which is burning at that instant will continue to burn until the end of its half cycle; but, owing to the presence of the blocking potential on its grid, the next anode in the sequence will not ignite. The rectifier can, therefore, act as its own circuit breaker, and will interrupt the circuit very rapidly. In the experiment this was illustrated by opening the switch and breaking the circuit which provided the positive potential for energising the grids; but in practice the operation is performed by means of a high-speed relay—see (*b*) Fig. 6—operated either by the output current or the current on the primary side of the transformer. The relay merely closes a circuit which applies a negative potential, and as it deals with

extremely small currents it can be made to have small inertia and to operate in less than $^1/_{1000}$th of a second.

Voltage Regulation.

The third experiment was designed to show that smooth voltage variation can be obtained on the D.C. side of a rectifier by means of control grids. The scheme of connections is shown at *c* in Fig. 6, where it will be gathered that the positive impulses are applied to the grids by means of a contact-making device driven by a small synchronous motor. At each anode the arc is ignited at the instant the control grid becomes positive relative to the cathode, and by displacing the contact disc it is possible to vary the ignition over a considerable angle. A displacement of less than 120 electrical degrees gives a smooth range from full voltage down to zero. The later the instant of ignition the lower is the voltage obtained on the D.C. side. The energy required for controlling the grids is not more than 40 watts, even on a large steel tank rectifier.

Motor Speed Control.

The load in the case of the diagram, Fig. 6 *e*, which relates to the fourth experiment, consists of a motor which is separately excited from an external source. A change-over switch makes it possible to reverse the connections of the motor armature relative to the rectifier terminals. The D.C. voltage is first of all reduced to zero by advancing the points of ignition and the circuit to the motor is then closed. By advancing the contact disc the voltage of the rectifier is increased, and the motor runs up to speed, when the D.C. voltage is determined by the back E.M.F. of the motor, and gradually rises as the speed increases. To maintain the motor current approximately constant, the ignition point must be changed still further, thus increasing the voltage of the rectifier until the full speed of the motor has been obtained. With this connection regenerative braking is not possible without reversing the motor leads, as current cannot be passed through the rectifier in the opposite direction. A return of power must be obtained by reversing the voltage of the load. Either the field or the armature of the motor may be reversed, when the rectifier will withdraw energy from the machine and feed it back to the supply system, and after the machine has come to rest the rectifier will supply current to run it up to speed in the opposite direction. During acceleration of the motor the rectifier acts as a converter, but during regeneration it becomes an inverter and returns power to the supply system.

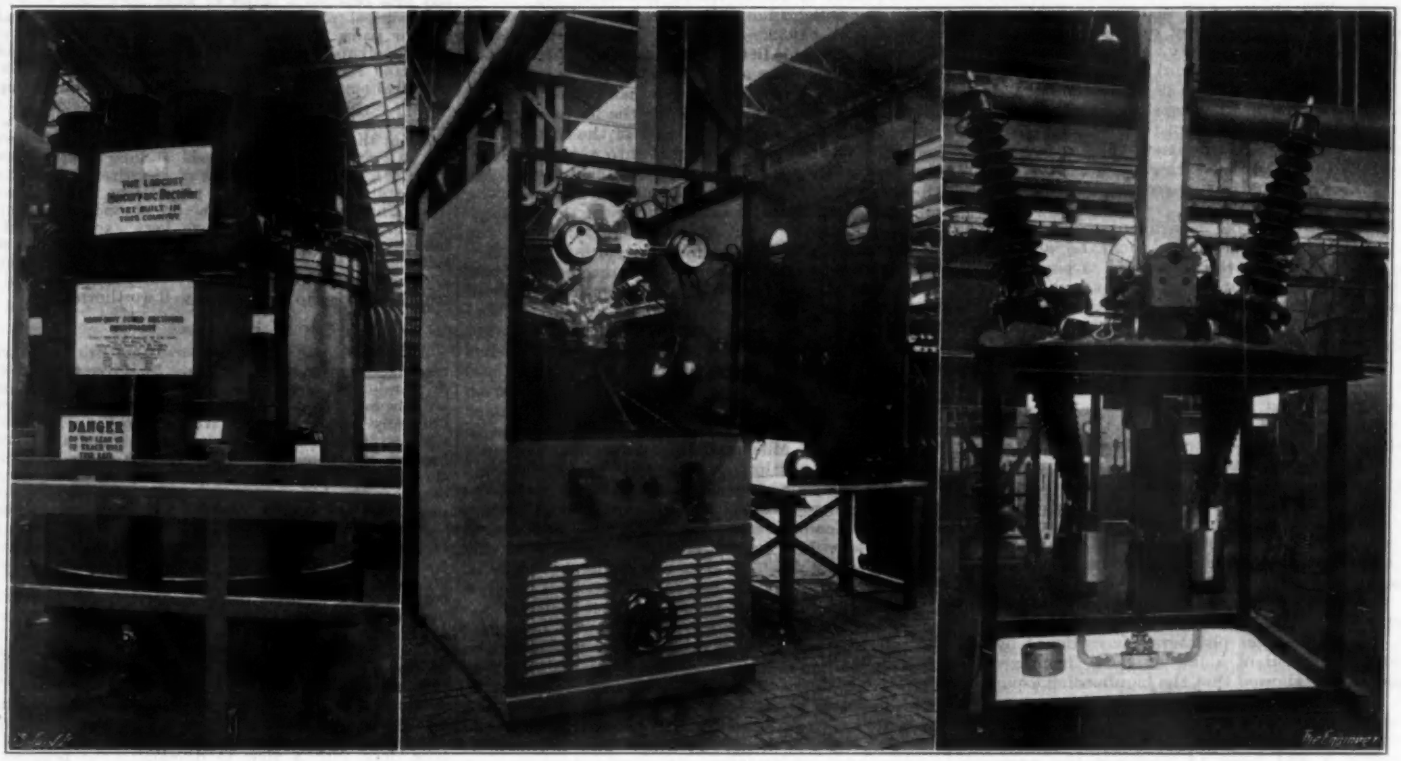


Fig. 1—Steel Tank Rectifier

Fig. 2—Glass Bulb Rectifier

Fig. 3—De-Ion Contact Circuit Breaker

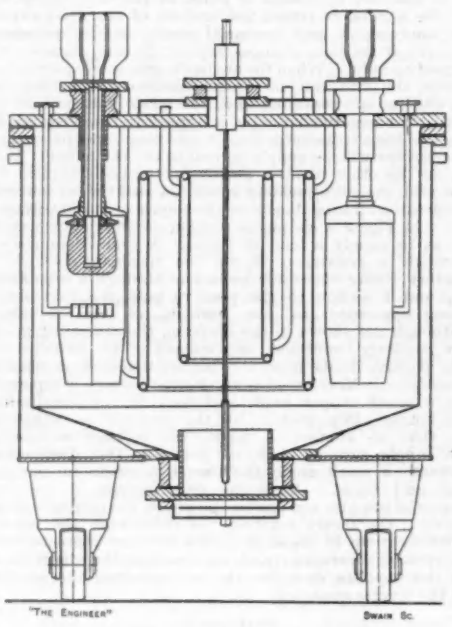


Fig. 4—Grid Controlled Rectifier

The Ward-Leonard System.

With the aid of two rectifiers arranged as shown at *d* in Fig. 6, a rolling mill motor can be controlled in accordance with the Ward-Leonard principle, and without the use of a change-over switch. The two rectifiers are fed jointly from the A.C. system, and if necessary they can have a common transformer with separate secondary windings, and the choke coils may have a common iron core. On the D.C. side both rectifiers are switched in parallel with their voltages in opposition, but owing to the non-return properties of the grid-controlled rectifier one unit does not form a short circuit to the other. The control of the two rectifiers can be carried out by a single lever in such a way that the voltage on the system can be regulated at will between its positive and negative values. The motor can then start in either direction and take its energy from one rectifier, whilst on a movement of the control lever the other rectifier becomes an inverter and gives a braking effect by regeneration through the rectifier on to the line. Again, the control mechanism is quite simple, and operates on the control grids through circuits, which only have to deal with a few watts.

Interconnection of A.C. Systems.

By arranging grid-controlled rectifiers, as shown at *f* in Fig. 6, they can form a D.C. link between two A.C. systems, and give complete control over the flow of power in either direction. The two systems may, of course, have different frequencies, and they may differ as regards the number of phases. Assuming that system 1 is in need of power and that system 2 is able to meet the need, then the control of the two rectifiers is arranged so that rectifier No. 2 can act as a converter and No. 1 as an inverter, which feeds back on to the system. The only difference in the two cases lies in the instant of anode ignition. The converter anodes have their ignition advanced, whilst that on the inverter anodes is retarded. By slight alterations of the instant of ignition of one of the rectifiers the D.C. flowing in the line can be regulated and the power is transmitted from one system to the other.

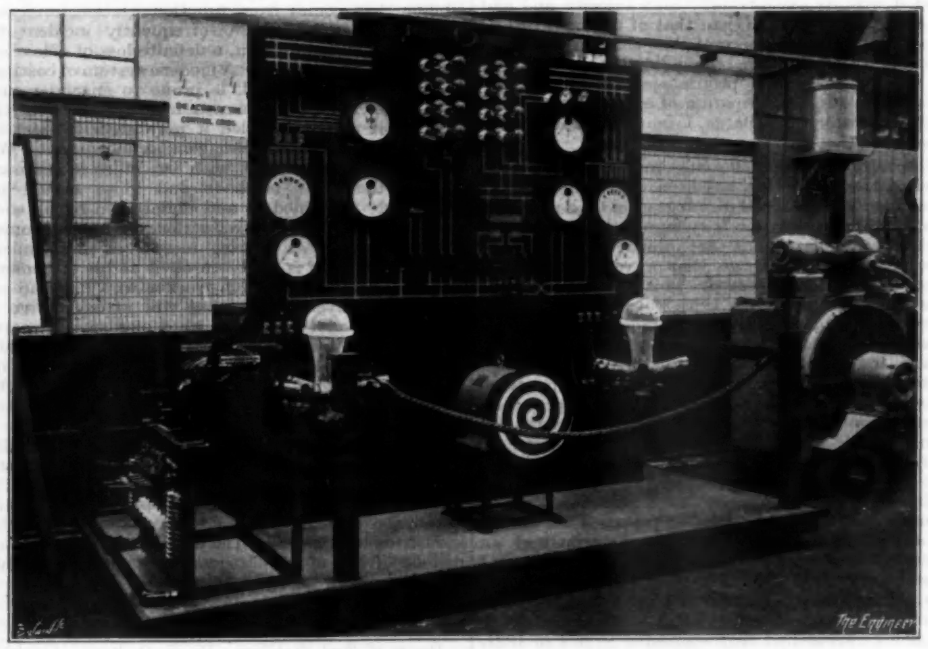


Fig. 5—Rectifier Demonstration Equipment

Generation of Sine Voltage Waves.

For this experiment two grid-controlled rectifiers are employed, as shown at *g* in Fig. 6. One of them supplies the positive half waves and the other the negative half waves of the system. By suitably connecting the rectifier grids to the actuating mechanism, a pendulum movement of the control lever of the distributors causes the voltage of the D.C. circuit to swing between its positive and

negative maximum values. The lamps indicated in the lower part of the diagram light up during each voltage swing; in other words, twice in one complete voltage cycle. By switching off either of the rectifiers, it can be shown that each unit is supplying one-half wave of each cycle. As the frequency generated is determined by the velocity of the pendulum movement, the experiment demonstrates that it is theoretically possible to obtain any frequency by grid control. The pendulum movement would be replaced in practice, however, by vibrating contacts or other apparatus designed to meet requirements.

Frequency Changing.

At *h* in Fig. 6 a scheme is shown for obtaining a single-phase voltage having a frequency lower than the 3-phase supply frequency. In the actual experiment the supply frequency was 50 and the reduced frequency 16⅔ cycles. The connections are self-explanatory. The two rectifiers are controlled so that they alternatively supply one-half wave of the lower frequency by connecting the output circuits of the rectifiers in opposition. The alternative half waves of the lower frequency voltage are combined to produce the required single-phase A.C. voltage, this being accomplished by connecting one-half of one winding of a single-phase transformer in the output circuit to the lower frequency system. The control potentials are applied to the grids by means of special grid control apparatus, and the control of the grid potential is arranged so that a certain portion is extracted from each successive half wave of anode voltage, and so that the average value of these successive portions provides the required half wave of the lower frequency single-phase voltage. Current flows alternatively from each rectifier through the corresponding half of the transformer winding to which it is connected. As these currents flow alternatively in opposite directions they give rise to an alternating flux in the transformer, which induces the required low-frequency A.C. voltage in the winding connected to the single-phase circuit.

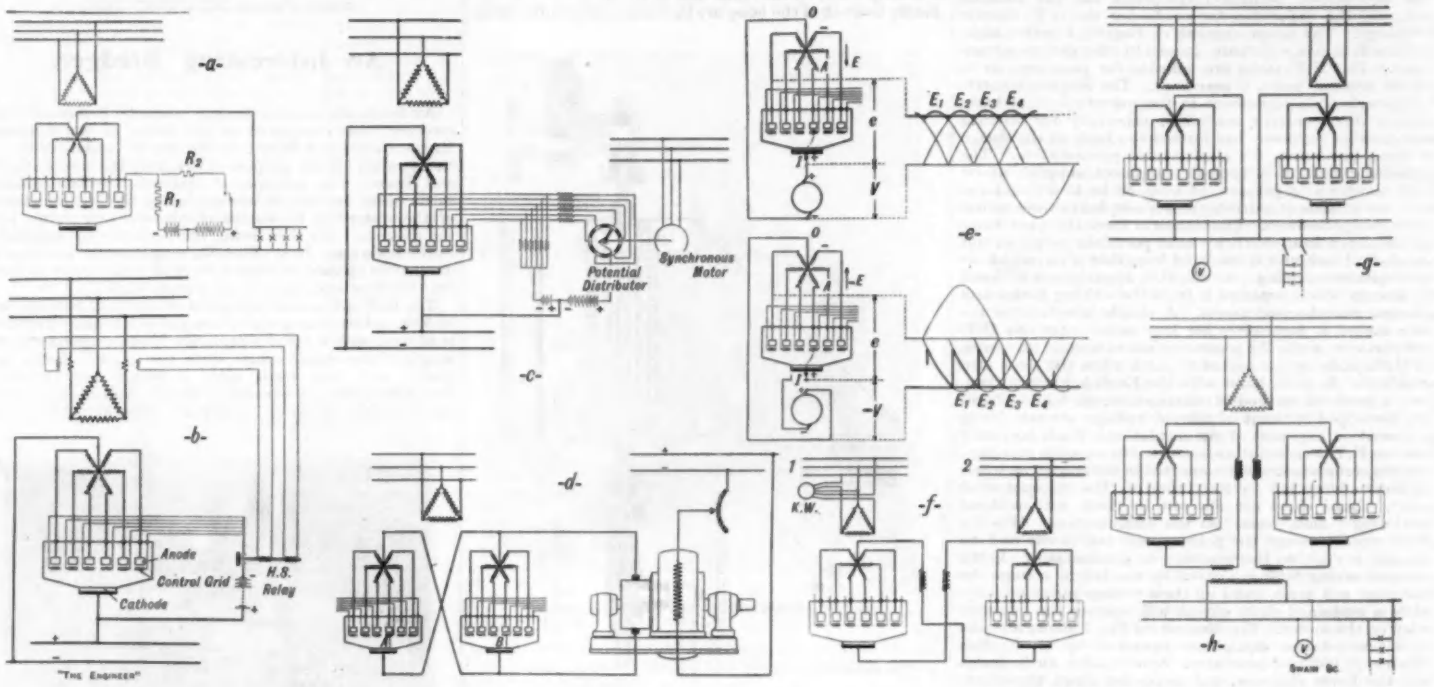


FIG. 6—DIAGRAMS SHOWING POSSIBLE RECTIFIER APPLICATIONS

Switchgear.

A single-phase circuit breaker fitted with de-ion contacts—see Fig. 3—was among the switchgear exhibits. The general principle of the de-ion contact is now fairly well known. When circuit breaker contacts separate the space between them becomes highly ionised, and an arc is produced, which vaporises the insulating medium, and, owing to the weakening of its insulating properties the arc can persist with a comparatively low voltage. Realising that it is difficult to force a jet of oil into an arc, attention has been directed to forcing the arc into contact with the oil. The de-ion contact acts upon the arc from the moment it is formed, and forces it into contact with the oil, which cannot readily escape, while the gases produced are used to de-ionise the arc stream. The system of control continues to attack the arc along its entire length and up to the time of final extinction. The illustration, Fig. 3, shows a de-ion contact stack mounted on each of the fixed contacts of a single-phase circuit breaker. The laminated structure of each stack consists of insulation elements, magnetic elements, and oil pocket elements, each having slotted openings which register to form a deep and relatively narrow groove, through which the arc is drawn by the movement of the contact bar, the oil being held within the structure by means of the oil pockets in such a way that it cannot readily escape. Substantial plates at the top and bottom and insulated assembly bolts hold the complete unit rigidly together, and to prevent absorption of moisture during transit or while the apparatus is in store, the complete stacks are impregnated with oil.

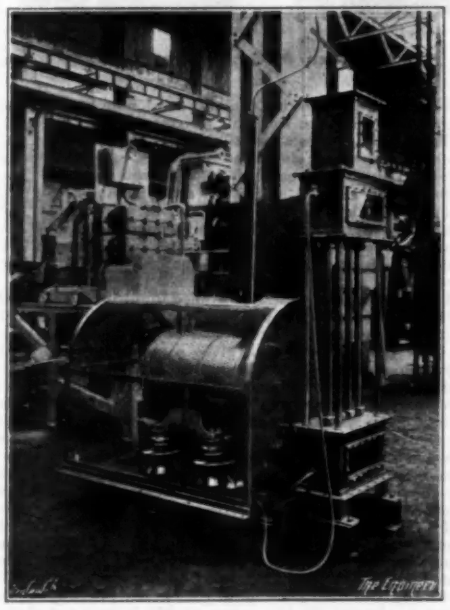


FIG. 7—MODEL OF PRECIPITATION EQUIPMENT

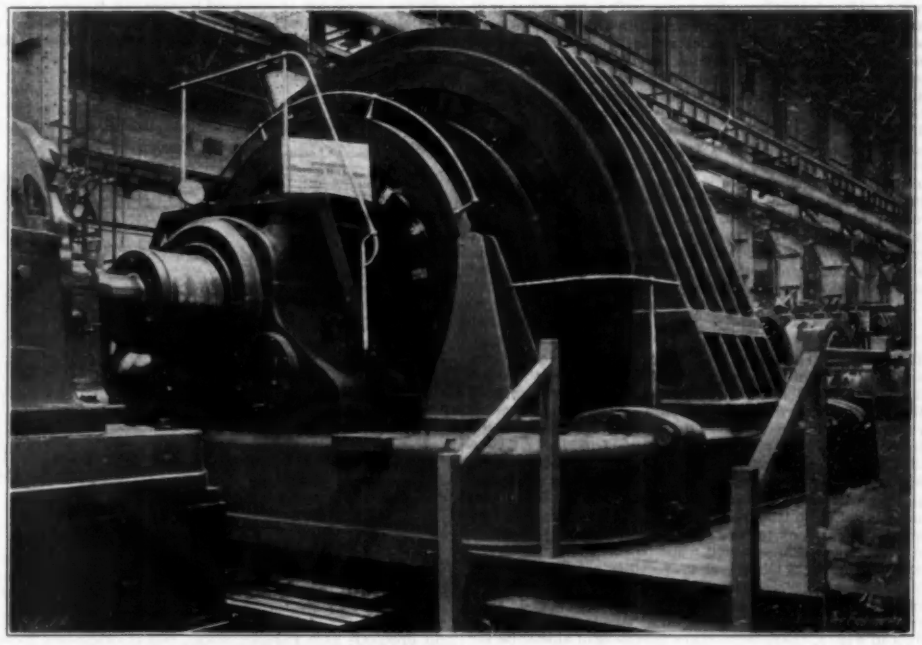


FIG. 8—REVERSING MILL MOTOR

The extinction of an A.C. arc is mainly dependent on two factors: (1) the rate at which the arc space recovers its dielectric strength after the current ceases to flow at the zero point of the wave; and (2) the rate at which the voltage applied to the arc terminals by the external circuit builds up. The de-ionising method of arc control aims at speeding up the recovery of dielectric strength in the arc space. When the sparking contacts separate an arc is formed between them, thus vaporising the confined oil in the immediate vicinity. The vaporised oil can only escape by passing through the arc stream, and this produces violent turbulence in the arc space, breaking up the arc stream into numerous smaller streams and tending to keep the degree of ionisation uniform throughout the arc space. Upon the current falling to zero the arc is extinguished and the production of ions ceases, but de-ionisation due to recombination and direct loss continues, the whole process being considerably accelerated by the uniform state of ionisation in the space previously occupied by the arc, so that the insulation of the space between the contacts rapidly rises to its maximum value.

On opening the breaker the contacts separate and an arc is drawn between the stationary and moving contacts in the slot of the de-ion stack. As the contact bar moves downwards towards the fully open position the arc is drawn through the air gap of the iron plates, which are magnetised and produce a field across the gap. During further downward motion of the moving contact the arc is drawn across the field of each succeeding magnetic plate and the magneto-motive forces across the air gaps act so as to force the arc towards the closed side of the slot. The magnetic sections of each stack are interleaved with groups of plates shaped in such a way as to form oil reservoirs that hold a considerable quantity of fresh oil with which the arc is maintained in contact. These oil pockets are divided into several compartments separated from each other by closely restricted passages which ensure that sufficient oil is retained until the de-ionising process is complete.

The chief advantages claimed for these de-ion contacts are:—(1) The arc is controlled so that the energy to be dissipated is reduced to a minimum; (2) the arc is interrupted at the earliest possible moment consistent with the safety of the system; (3) the de-ion contact acts upon the arc immediately it is formed and continues its attack as long as it persists; (4) the arc is forced into and is maintained in contact with fresh clean oil; (5) as the contact bar moves downwards and the arc lengthens additional de-ionising chambers come into action automatically; (6) oil depreciation is greatly reduced; (7) the

renewable arcing parts are inexpensive and are easily replaced; (8) the tanks and mechanical parts of the breaker can be earthed; (9) no auxiliary apparatus is required; and (10) the de-ion contacts can be fitted to existing English Electric circuit breakers. Other examples of the company's switchgear, including a large metal-clad compound-filled circuit breaker pillar, a flameproof circuit breaker pillar for mining service, were exhibited.

Electrostatic Precipitation Plant.

Electrostatic precipitation plant—Fig. 7—has been designed in collaboration with the Whessoe Foundry and Engineering Company, Ltd., which has specialised in the development of apparatus for fog and mist extraction. The equipment, naturally, comprises the gas treating unit and the apparatus for producing the H.T. electric discharge. The latter consists of English Electric high-tension dynamos, which are claimed to offer various advantages. The H.T. units are suitable for pressures up to 45,000 volts or more, if necessary. The English Electric Company's wide experience in the manufacture of high-tension direct-current machines, especially for wireless transmission purposes, has formed the basis of the design of these generators for electrostatic precipitation. The generating unit of a typical equipment supplies about 0·15 ampère at a pressure of from 40 to 45 kV and the machine consists of a driving motor coupled to three series-connected generators. The frames of these three machines are insulated from earth by solid porcelain supports, and the shaft of each unit is insulated from that of its neighbour by a suitable coupling. All the H.T. apparatus is enclosed by screens which separate it from the driving motor and prevent unauthorised access. A simple interlock on the door makes it impossible for anyone to enter the H.T. compartment while the generators are running. Moreover, all H.T. parts are connected to earth when the set is at a standstill. In accordance with the English Electric Company's patented method of construction, the high voltages are developed without abnormal voltage stresses being produced on any part of the insulation. Each generator has two H.T. commutators connected to separate windings, and the commutators are connected in series with an intermediate connection to the frame at the mid-potential point. Dead short circuits can be dealt with without producing "flash-overs" at the commutators. When a short circuit occurs the field rapidly falls away and no damage is done to the windings or commutator. If the external arcing fault is cleared by the fall in voltage the machines will again build up their voltage automatically, while a sustained short circuit will operate the overload relay on the motor. The illustration Fig. 7 shows a model of a precipitation equipment operated by an English Electric 15,000-volt generator. Smoke-laden air is drawn into the lower chamber, and suspended down the centre of each vertical earthed tube is a wire charged to 15,000 volts by the special D.C. generator. The air in the upper chamber is purified, the suspended matter being precipitated by electrostatic action and deposited in the lower chamber.

Reversing Blooming Mill Motor.

From the point of view of heavy engineering the 18,000 H.P. peak load reversing mill motor shown in Fig. 8 was the outstanding exhibit. Limitations of space will not allow us to deal in detail with all the equipment for the contract which was placed by the new steel works of the South African Iron and Steel Industrial Corporation. Briefly, the contract comprises the whole of the electrical equipment for the main drives, together with a large quantity of sub-station equipment. The blooming mill installation consists of a reversing mill equipment to give a peak load of 18,000 H.P. at 80 r.p.m. and a speed variation from zero to plus or minus 180 r.p.m., and is being supplied complete with a variable-voltage motor generator Ilgner set and exciter set. The motor generator consists of a 4200 H.P. induction motor driving three 1455-kW generators and a fly-wheel of 160,000 H.P. seconds, all rigidly coupled together and running at a maximum speed of 600 r.p.m. The three generators are connected in series to give a maximum pressure of 1440 volts. The blooming mill motor is intended to drive a three-stand reversing mill, with cogging, roughing, and finishing housings for dealing with 2-ton ingots and turning out billets, various merchant bars, rails, &c. The somewhat high speed of the machine is due to the desire to finish off the long passes rapidly.

Miscellaneous.

The standardisation of frequency on the North-East Coast has brought the company some important orders, and a number of large alternators that were originally built at the Stafford Works are now being reconstructed. Five large and two smaller alternators are being dealt with in this way for the Skinnin Grove Ironworks, where modifications are also being made to the rolling mill equipment, involving new induction motors for the cogging and finishing mill drives, this contract being one of many that have been undertaken in connection with the change of frequency on the North-East Coast.

Among other things which went to form the exhibition of special products were various rectifier auxiliaries, such as a phase equaliser, an auxiliary control panel, a direct-current smoothing equipment, and a high-speed D.C. current limiter. Besides the large steel tank rectifier shown in Fig. 1, there were other rectifiers of this type for smaller outputs and rectifier parts. A 12,000-volt D.C. motor generator for the British Broadcasting Corporation was also in evidence. A 200 H.P. high-speed oil-electric generating set for traction purposes was, we believe, the only exhibit that represented the combined efforts of the Stafford and Rugby works, but various things, such as industrial motors and control gear, electric fires and cookers, came from the company's Bradford works. Needless to say, the company's transformer and induction regulator departments were represented, and a good example of a tap-changing transformer was on view in the shops. But the most novel and fascinating feature of the specially arranged exhibition was the rectifier demonstration equipment, which must have caused many to wonder what influence the rectifier will ultimately have on present-day electrical practice.

A New Boiler Water Level Indicator.

The accompanying engravings illustrate a new boiler water level indicator recently brought out by Dewrance and Co., Ltd., of 165, Great Dover-street, London, S.E. Observation of the water level is brought right down to the firing floor itself, and the steam space in the gauge glass shows red, while the water space is green. Fig. 1 shows the component parts of the gauge, which in all respects, except that of the colouring, is similar to the firm's standard.

The source of illumination is a strip electric lamp, which is usually fitted on the boiler side of the indicator. Immediately in front of the lamp are two strips of coloured glass,

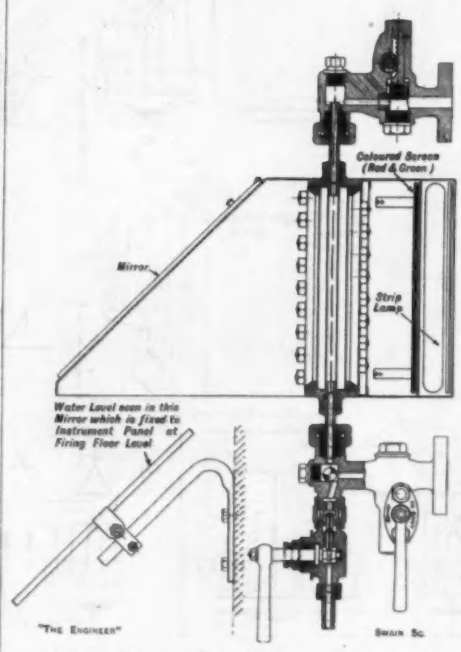

Coloured Screen (Red & Green)
Mirror
Strip Lamp
Water Level seen in this Mirror which is fixed to Instrument Panel at Firing Floor Level
"The Engineer"
Swain Sc.

FIG. 1—BOILER WATER LEVEL INDICATOR

one of which is red and the other green. In front of these, again, is a long lens of similar length. These fittings are housed in a black japanned metal container, and the whole is attached to the body of the indicator. As will be seen from Fig. 2, the indicator glasses, instead of being rectangular, are so ground and bedded that their inner surfaces are inclined at an angle to each other. The sketches in Fig. 2 show, in diagrammatic form, how the changes of colour are brought about.

From the electric lamp beams of light travel through coloured glasses, which are tinted red and green respectively. The red beam of light, after passing through a lens, proceeds as a parallel beam, and when the space between the glasses is occupied by steam it travels straight through the indicator, as shown at A on the sketch. The green beam of light is also projected through the strip lens

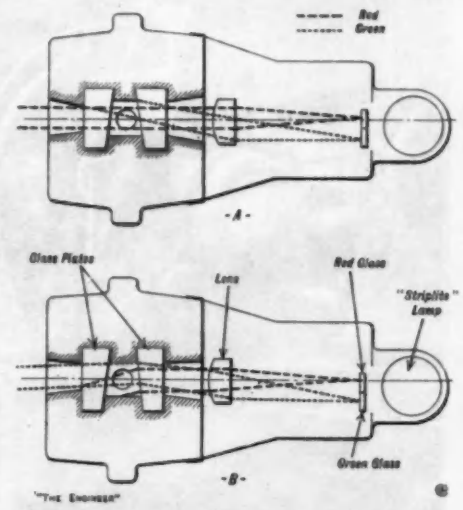


FIG. 2—PRINCIPLE OF OPERATION

and proceeds as a parallel beam, but it originates from a point off the centre line of the indicator. After travelling through the glass and the steam space, this green beam strikes the inside of the body of the indicator, and is not seen by the observer. When water takes the place of steam between the glasses, however, it acts as a prism, and the coloured beams, striking the side of this prism obliquely, are bent by refraction. The rays of light are thus deflected so that when the lamp is correctly positioned the red beam (which with steam was visible) strikes the inside of the body and is lost to view, and at the same time the green beam (which with steam was invisible) is deflected into the line of sight of the observer, as shown at B. Thus, all the space in the sight glass occupied by steam is illuminated red, and all the space occupied by water is illuminated green.

The steam and water spaces are thus shown in distinct contrast, and the rise and fall of the water in the sight glass is very clearly seen in the two distinct colours.

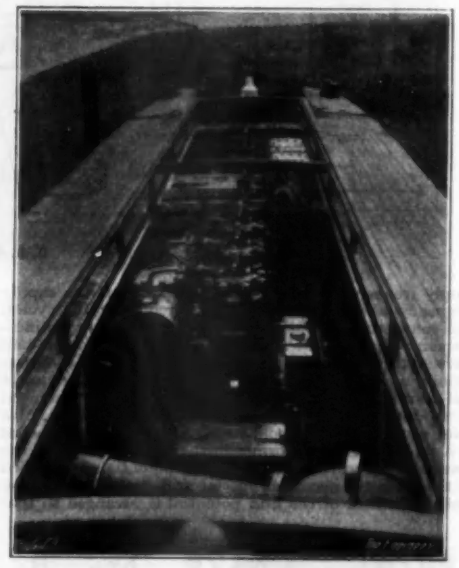
This illuminated water level indicator can be incorporated with a simple form of periscope to bring the image of the indicator down to the stoker's eye level, as shown in Fig. 1, or, if desired, it can be arranged for direct observation.

We recently had the opportunity to inspect this indicator in the maker's works. The indicator itself was placed on the upper gallery of a high shop in the works below a clean, well-lighted skylight. No covers or guards were placed round the periscope glasses, but nevertheless, when water was introduced into the indicator there was no difficulty whatever in seeing the exact position of the water level.

An Interesting Dredger.

An hydraulic erosion dredger named "Persevere" has recently been completed to the order of the Somerset Rivers Catchment Board by Messrs. W. and F. Wills, of Bridgwater, for the purpose of dredging the rivers Parrett and Tone. The principle of hydraulic erosion consists, as its name implies, in washing away the bed and banks of the waterway by means of high-velocity water jets, the disturbed silt then being carried away in suspension to the open sea. It is, of course, necessary for this type of dredger to operate in either a river or tidal waters in order that the flow of water may carry away the silt.

The hull of the new dredger is of steel and has a length of 50ft., a 10ft. beam, and a draught of 3ft. 3in. The deck is of teak and is fitted with a low hatch running the full length of the engine space, while the usual bollards, fair leads, and two small hand capstans are provided. The power plant, illustrated by the accompanying engraving, consists of two 75 B.H.P. three-cylinder Petter



POWER PLANT OF DREDGER

"Atomic Diesel" marine engines, one for propulsion, the other for driving the hydraulic eroding plant. The propelling engine drives a propeller of 3ft. diameter and 6ft. pitch through a very short shaft and stern tube. Reversing is carried out by means of an epicyclic reverse gear. The engine gives the boat a speed of approximately 8 m.p.h. when operating at its normal speed of 400 r.p.m. The exhaust of each engine is led out through the side of the boat, as, owing to the low height of some of the bridges under which she has to pass, the use of a funnel is precluded.

The other engine, which is installed immediately forward of the propelling engine, drives a pair of specially designed centrifugal pumps through a gear-box fitted to the bed-plate of the engine, which gives a step-up in speed of approximately 3·9 to 1. The pumps, which have impellers and guide blades of gun-metal, are driven from the gear-box by two short shafts, and are coupled together in series. There are six erosion jets of special design, supplied by the pumps with water at a high pressure, and it is possible to operate one, two, or four of the jets at the same time to suit the conditions. The inlet of the pumps and the deliveries of the various jets are controlled by means of quick-acting sliding sluice valves.

Two of the six erosion jets point vertically downwards about 8ft. apart at the turn of the bilge and in line with the pumps, while immediately above and just below the water line are two more, inclined downwards at an angle of 12 deg. from the horizontal. A further submerged jet, which can be swivelled from side to side, is arranged at the bows and is used for cutting new channels or deepening the water sufficiently for the passage of the boat. Lastly, there is another swivelling jet on deck, which is used for trimming the banks. The underwater jets on this particular boat are efficient for a distance of 15ft. on either side, thus cutting a channel 40ft. wide.

The "Persevere" is under the supervision of Mr. F. B. Goodman, M.I.M. and Cy. E., Engineer to the Somerset Rivers Catchment Board, and is responsible for some 40 miles of waterway for drainage and irrigation purposes. She carries a crew of three, one man each for the boat, the jets, and the engines, and it is hoped, we understand, to supplement her in the near future with a further boat of similar type.

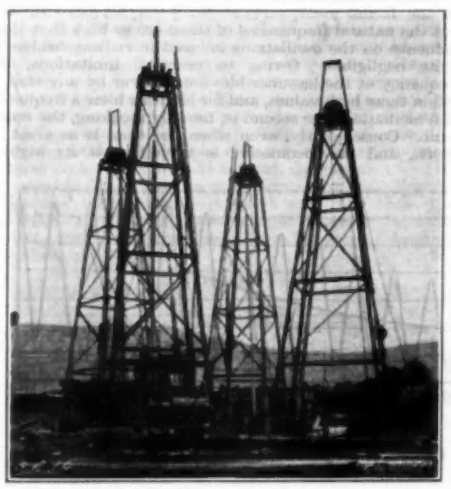
The main fuel tanks have a capacity of 2 tons 16 cwt. and are so distributed as to keep the boat in good trim

when full. The engines are supplied with fuel direct from a gravity tank of 25 gallons capacity, to which fuel is raised from the main tanks by a pump on the pumping engine.

Shaft Sinking by the Freezing Process.

THE construction of a new electric power station at Swansea necessitated, amongst other operations, the sinking of two vertical shafts in water-logged ground, an intake being required in the King's Dock area and a discharge shaft in the Queen's Dock area, each shaft being 14ft. in diameter. Owing to the presence of water in the underground strata, it was decided to carry out the shaft sinking by adopting the freezing process, in order to facilitate the work. Briefly, this process consists of consolidating the strata round about each shaft by freezing by means of freezing tubes inserted into the ground, thus completely isolating the shafts from the adjacent strata. In order to insert these tubes, however, a series of bore-holes has to be drilled. The freezing tubes are then inserted and the lining tubes of the bore-holes withdrawn. During the process of insertion the freezing tubes are tested hydraulically at 200 lb. per square inch at frequent intervals, as it is essential that no leakage of brine shall take place.

It was necessary to drill two series of twenty-four bore-holes on the periphery of a circle 22ft. in diameter, the bore-holes being placed 2ft. 10½in. apart, and the greatest care had to be taken to ensure the verticality of these borings. The accompanying engraving shows the percussion drilling rigs employed. During drilling



PERCUSSION DRILLING RIGS

operations boulders were met with which tended to divert the holes out of the vertical. These difficulties were, however, successfully overcome, and it was found quite possible to drill to the full depth of 172ft. with a deviation of only a few inches. In addition, a pilot hole was first drilled to a depth of 250ft. by the shot rotary method with the following objects:—To obtain accurate samples of the strata by means of cores; to enable the engineers to determine the correct depth of the ring holes; to enable the temperature of the ground to be taken during the freezing process; and to prove approximately what quantity of water would be met with below a depth of 170ft.

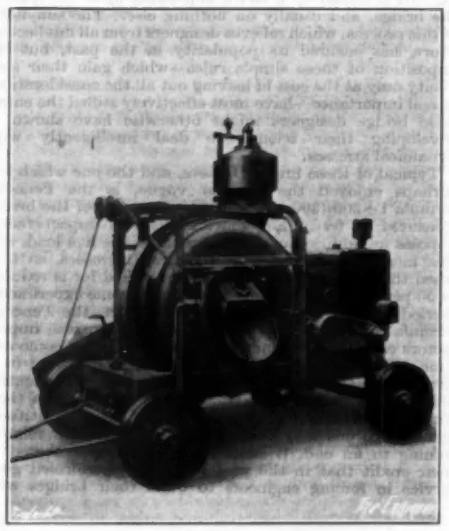
Four special boring rigs, designed by LeGrand, Sutcliff and Gell, Ltd., of Southall—who performed the drilling operations—and driven electrically by 30 H.P. motors, were employed. The work was carried on continually day and night.

Woven Belting.

WE have had submitted to us for inspection a sample of woven belting dressed with a new material, and are impressed by the qualities as far as they can be estimated from inspection. Woven power transmission belting is made from hair or cotton yarns in the warp, with cotton binding and weft threads. Such belts are bound and consolidated by impregnation with an appropriate substance, and it is in the nature of this impregnating material that the sample before us, made by J. H. Fenner and Co., Ltd., of Hull, differs from others. This new material, known as "Z" dressing, is largely composed of pure rubber, and inspection shows that the difficulty of getting complete penetration of the tightly woven fabric with rubber has been overcome. It is claimed that this dressing gives a high coefficient of friction, and that belts made with it have a desirable degree of elasticity and are resistant to corrosive fumes. We understand that it is intended to dress conveyor belts by the new process, which, we are happy to say, is wholly British.

Seven Cubic Feet Concrete Mixer.

A NEW form of concrete mixer, known as the Super Victoria Seven, made by Stothert and Pitt, of Bath, is shown in the accompanying engraving. It is capable of producing mixed batches of 7 cubic feet from an unmixed batch of 10 cubic feet. As will be seen from the illustration, it is of the type having a drum rotating about a fixed axis, into which the mixture is shot on one side, while the concrete is withdrawn on the other side, both through central holes. The drum shell consists of a steel cylinder with pressed steel ends electrically welded together. The ends form the runway tracks on which the drum rotates on rollers. The toothed driving ring, in the centre, is made in sections, and so arranged as to facilitate renewal. Inside the drum there is a series of baffles which effectively turn over and mix the batch. The aggregate is introduced by a tilting hopper, which is operated by a power-driven winch and the discharge is effected by a shoot swung into position by hand. The water is taken from a 12-gallon tank, which is equipped with a telescopic syphon tube, so that the discharge can be regulated to the one-fifth of a pint. The power unit is an 8 H.P. high-speed Lister oil engine, which is totally enclosed and drives



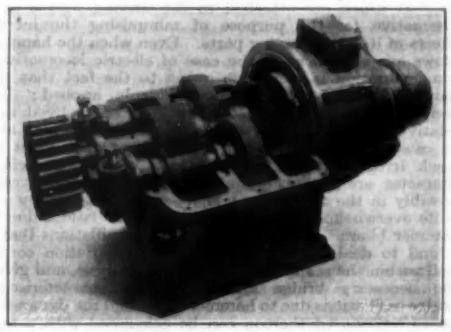
SEVEN CUBIC FEET CONCRETE MIXER

through chain gearing. Ball bearings are fitted to all the continuously running shafts, and grease gun lubrication, except for the engine.

The machine is standardised with alternative under-carriages. A four-wheel or two-wheel truck with steel or rubber-tired wheels can be fitted. Swivel wheels to convert from side to end discharge are provided. The special two-wheel truck model for end discharge and ease of transport is a new feature. The four-wheel arrangement weighs 1¾ ton.

Pericentric Helical-Geared Motor.

THE "Pericentric" helical gearing developed by David Brown and Sons (Huddersfield), Ltd., is already well known; the latest design of an electric motor and gear unit is illustrated by the accompanying engraving. The motor is bolted to the end of the gear-box and may be removed axially, together with its pinion without disturbing any of the rest of the mechanism. For use on a further reduction gear the unit illustrated is fitted with a pinion on the end of the low-speed shaft. This shaft is supported on two bearings, one on either side of the final wheel of the gear train. The bearing nearest the



PERICENTRIC HELICAL-GEARED MOTOR

motor is supported by a cross-wall, which also carries the layshaft bearings and helps to make the box resistant to distortion. Since there are two layshafts the pinion on the motor is subject only to pure torsion and may, therefore, be overhung with safety, while the arrangement also saves wear on the low-speed shaft bearings which have only to carry the weight of the final drive wheel and are not called upon to meet any thrust. The two layshafts are free to float and are interconnected externally by a pair of levers pivoted centrally which take up a position of equilibrium with balanced equal and opposite end thrusts. All the gears and shafts and bearings may be lifted out for inspection without disturbing the foundations, and the makers claim that a full load efficiency of 98 per cent. can be maintained over a long life.

THE hearing of the railway companies' application for a reduction in their men's pay comes before the National Wages Board on November 29th.

Canadian Engineering News.

(By our Canadian Correspondent).

Lumber Trade.

LUMBER shipments from British Columbia in July dominated the trade on the Pacific Coast, and for the first time in the history of the industry in that area mills in the Canadian province shipped more lumber to overseas markets than did the combined mills of Oregon and Washington, in the United States. Australia and the United Kingdom, two important markets now practically closed to American mills owing to preferences extended to Canada, accounted for the great bulk of the British Columbia exports. During July, shipments of lumber from the Pacific North-west totalled 72,800,000 board feet. British Columbia mills shipped 43,400,000ft., or 59·6 per cent. of the total; Washington mills shipped 20,200,000ft., or 27·7 per cent.; and Oregon mills 9,200,000ft., or 12·6 per cent.

Improved Highways.

The nineteenth annual meeting of the Canadian Good Roads Association, held at Digby, Nova Scotia, during the second week in September, and attended by some two hundred delegates from seven provinces, signalised one of the most successful consultations of this character held since the Association began its career. The addresses turned upon the remarkable development of the good roads movement, coupled with the discussion of present needs and of the ways and means of making still further advance. As each province submitted its report it became manifest that although, twenty-five years ago, the scheme in favour of improved roads was novel, and struggling for utterance, to-day many millions of dollars are spent annually upon the construction of new highways and upon the maintenance of existing roads. According to the report emanating from the Dominion Bureau of Statistics, 60,247,410 dollars was last year expended upon the construction of highways in Canada, and 22,287,153 dollars was spent on their maintenance.

Up to the present it is estimated that a total of 140,000,000 dollars has been spent upon improvement of the public highways in the province of Quebec alone, and other provinces exhibit also a most notable advance in the matter of good roads building.

Road costs have steadily decreased in recent years, being 45 per cent. below the peak prices of 1924. Credit for the decline is due to engineering research, to contracting organisation, and to continuous improvement in equipment design, permitting rapid construction, while quality has steadily improved, resulting in longer life for pavements.

In his lecture on "Winter Maintenance of Roads," C. A. Robbins, Engineer of the Ontario Department of Highways, stated that this comparatively new problem for Canada involved the tasks of drift prevention, ice and snow removal, and surface maintenance. The Ontario Highway Act permits the erection of snow fences on lands adjoining the highway without compensation to the owners, except where crop damage is done. Wire-bound slat-fence has been found most satisfactory, being easy to erect and to store. The fencing is located parallel to the road and about 100ft. from its centre, with a second fence 75ft. distant if necessary. Liberal use of snow fence has greatly reduced the work of winter maintenance.

Snow removal is accomplished by rotary "V" type and blade ploughs, attached to heavy-duty trucks. Some are operated by the Highways Department and others by contractors, on patrols of lengths varying from 25 to 75 miles, according to average snowfall. Near large centres, the pavements and shoulders are cleared entirely of snow, but in other sections sufficient snow is left for sleighing.

Slippery conditions due to ice or frozen snow are combated with sand or cinders, to which a proportion of calcium chloride is added, to prevent the piles of material freezing before use. A light sand-spreader applies sand at the rate of 8 to 10 miles per hour, and is more saving of sand than hand-spreading. Special efforts are made to keep bridge floors clear of snow and ice.

Speaking of the damage done to roads as a result of snow removal, Mr. Robbins said that gravel roads become rutted and full of potholes, but prompt maintenance work in the spring prevents permanent damage. The effect on surface-treated, waterbound macadam is more serious, and repair costs are excessive, but to bituminous macadam, cement concrete and sheet asphalt surfaces, the damage is negligible.

In 1931 the province of Ontario kept about 2500 miles of highway open all winter at a cost running from 80 dollars to 220 dollars per mile, with 160 dollars as the average. These roads carry an average daily traffic of 1200 motor vehicles. The yearly increase in traffic indicates that winter roads in Canada are no longer a luxury, but a necessity.

New Automotive Concern.

The Panyard Rotocam Piston Packing Company, manufacturers of piston rings for motor car engines, has purchased the rights for the British Empire from a Detroit, United States, company of similar name, and is starting production in Windsor, Ontario. The principals of the Windsor concern are James Roy, president; Paul Bernier, manager of sales and service; and John F. Panyard, inventor of the ring, in charge of engineering.

Montreal Enlarging Water Station.

The city of Montreal is carrying out a large programme of increasing pumping facilities for the city water system. Tenders have been called for three 30-million gallon pumps for the low-level pumping station at Point St. Charles. The city has also begun the construction of an extensive building for housing these pumps. The city's pumping plant now consists of six 30-million gallon pumps, or a total of 180,000,000 gallons per day. The new pumps will increase the pumpage by 90,000,000 gallons and bring the total capacity to

270,000,000 gallons daily. The new extension to the Point St. Charles station is being made large enough to install six 30-million gallon pumps, which would duplicate the existing plant. Old steam pumps have all been replaced by centrifugal pumps driven by electricity.

Growth of the Power Industry.

Hydro-electric power developments in Canada over the past decade have been carried on at a rate probably exceeding that in any other country in the world. Some idea of the tremendous growth that has been undertaken and which is now in progress, may be gathered from the fact that current developments call for an outlay in excess of 300,000,000 dollars. In all, over 1,500,000,000 dollars are invested in the industry. Canada is fortunate in its fuel and power needs, in having a bountiful supply of both where they are most needed. In the Prairies and the Maritime Provinces, where coal deposits are extensive, water power resources are limited. The other provinces, except British Columbia, are laking in coal, but they have a wealth of water power. It is not surprising, therefore, to find that the greatest developments in the power industry have taken place in Ontario, Quebec, and British Columbia. This fact is to be ascribed not only to the availability of huge water power resources, but also to the circumstance that the preponderance of population and industry in those areas calls for adequate supplies of power over and above that secured from coal.

Canada now has installed over 6,600,000 H.P. On a *per capita* basis, the Dominion ranks with the leading nations of the world in development and consumption. During the present century water power has become a vital factor in Canadian industrial development. The ample supplies of water power distributed from coast to coast have enabled Canada to develop into a manufacturing country of first-class importance. To an increasing degree the low cost of the power provided by hydraulic development has become a magnet attracting to the Dominion from abroad important major or branch industries, whose output has had a marked effect in augmenting Canada's export trade.

Current projects and those in contemplation are of such relatively enormous size, that doubt exists in the minds of many of the ability of the country to absorb the increased power as it becomes available. It is feared that the water power industry may go the way of the newsprint industry, and pass through a period of over-expansion. In considering this phase of the outlook for the industry, it is necessary to survey the possible outlets for power. In the last ten years the growth of the pulp and paper industry has been the cause of many hydraulic developments and the increase in consumption of power by nearly 1,000,000 H.P. The present standing of some of the major power producers is directly attributable to this expansion. At present the trend in industry is towards complete electrification. There are a number of Canadian manufacturers whose power requirements are already fully supplied by electric energy, but there is still room for considerable growth. While complete electrification is not altogether possible, the next ten years should witness a further increase in the consumption of electric energy for power purposes. The mining industry in Canada is almost completely electrified. Students of the water power industry are hopeful that the next decade will see the mining industry go a long way towards replacing the pulp and paper industry as a user of water power. They base this hope on many reasons, chief of which is that mining and smelting are capable of a very great expansion. Another field capable of great development is the electro-chemical industry, in which low-cost power is of paramount importance. A concrete example of what this industry can do for water power is seen in the great works erected on the Saguenay River, in the Province of Quebec, by Aluminium, Ltd., which uses several hundred thousand horse-power in the production of aluminium. Concurrently with this industrial development, the widespread distribution of power for domestic use not only in urban but also in suburban and rural communities, by the hydro-electric central station organisations, has in many different ways effected a decided improvement in the standard of living of a large proportion of the population.

Mineral Production.

Canada's production of metals, fuels, and non-metals reached a total value of 83,384,705 dollars during the first six months of 1932, compared with 95,689,288 dollars in the same period of 1931. The decline of 12·9 per cent. compared with the first half of 1931 resulted from abnormally low prices for base metals and greatly lessened demand for nearly all mineral products. Metals alone had a value of 54,092,915 dollars, compared with 61,717,841 dollars in the similar period of 1931. Copper output decreased 14 per cent. to 129,206,453 lb.; nickel production totalled 21,162,786 lb., as against 40,690,562 lb. for the first six months of 1931. Lead at 127,699,578 lb. marked a reduction of 13 per cent.; zinc output totalling 89,065,145 lb. was less by 33 per cent. Arsenic, cobalt, and metals of the platinum group also showed decreased production. Gold production made new history in Canadian mining with an output of 1,496,078 fine ounces, a greater amount than in any similar period and comparing with 1,273,808 ounces in the first half of last year.

New Tar Sands Discovery.

A discovery of tar sands in Northern Saskatchewan has been announced by the Provincial Department of Natural Resources, and tests will be conducted next year to determine whether the find is of commercial value or not. The deposit is located about 300 miles north of North Battleford. In Alberta, the Research Council of that province has been experimenting for some time with methods of separating oil from the bituminous sands of the Athabaska Valley near McMurray, and has met with considerable success. Recently it was announced that the investigators, Dr. K. A. Clark and Dr. D. S. Pasternack, had been able to recover practically 100 per cent. of the oil or bitumen by using a solution of soda ash. No information is as yet available as to the similarity of the newly discovered Saskatchewan deposits and the well-known deposits of the Athabaska River.

Dynamic Effects in Railway Bridges.*

By Professor C. E. INGLIS, F.R.S., M.A., LL.D.

I propose to bring to your notice some of the more salient points relating to the state of oscillation set up in railway bridges by the passage of locomotives or other moving loads.

For the calculation of stresses due to statical loads, mathematical analysis has reached a stage of evolution which hardly admits of much further advance; but, on its dynamical side, the science of bridge engineering cannot be viewed with equal satisfaction. This state of arrested development is largely due to the blighting influence of impact factors, which prescribe that the dynamical effect of a moving load shall be taken into account by multiplying this live load by a factor depending upon the span of the bridge, and usually on nothing else. The simplicity of this process, which relieves designers from all intellectual effort, has ensured its popularity in the past, but the imposition of these simple rules—which gain their simplicity only at the cost of leaving out all the considerations of real importance—have most effectively stifled the enterprise bridge designers might otherwise have shown in developing their science to deal intelligently with dynamical stresses.

Typical of these impact factors, and the one which has perhaps enjoyed the greatest vogue, is the Pencoyd formula $1+300/(300+l)$, where l is the span of the bridge measured in feet. For short spans this impact factor imposes an addition of 100 per cent. to the live load, and this increment decreases as the span increases, so that when the span is 300ft. the addition called for is reduced to 50 per cent. In 1920, as the result of some experiments carried out by the Ministry of Transport, the Pencoyd formula was recast, while in other countries impact factors expressed as functions of the span have come and gone with a rapidity which is only to be expected from formulæ which stand on no permanent logical or scientific foundation. But to heap ridicule and contempt on these empirical formulæ would be an act of base ingratitude, and though one may cherish the hope that their reign is coming to an end, it should always be remembered to their credit that in the past they have performed good service in forcing engineers to build their bridges with such an ample margin of strength that in most cases they have been able to stand up to the increased loads demanded by modern requirements.

The first really comprehensive attempt to put the problem of bridge impact on a scientific basis was made by the Bridge Stress Committee, which was established under the chairmanship of Sir Alfred Ewing in March, 1923, and published its report in October, 1928. As a member of that Committee my own activities were mainly engaged in evolving a satisfactory system of mathematical analysis, moulding it into shape until it fitted the facts, and pruning away unnecessary excrescences until it became a tool of reasonable simplicity and practical utility.

The vibrations set up by a train as it crosses a bridge are mainly caused by the hammer blows due to the balance weights which are attached to the driving wheels of a locomotive for the purpose of minimising the inertia effects of its reciprocating parts. Even when the hammer blows are absent, as in the case of electric locomotives, some vibration is inevitable owing to the fact that the moving load is more or less suddenly applied; but oscillations of this character are very short lived and relatively insignificant in character. Vibrations may also be caused by rail joints and the lurching consequent on track irregularities. Impact effects of this capricious character are obviously quite incalculable, and except possibly in the case of very short-span bridges, they are quite overwhelmed by the much larger oscillations due to hammer blows. It is with these latter oscillations that I intend to deal this evening. Their computation comes well within the scope of mathematical analysis, and given the necessary bridge and locomotive characteristics, bridge oscillations due to hammer blows and the dynamical forces consequent thereon can be calculated with a precision which is quite sufficient for all practical purposes.

Certain general ideas concerning the behaviour of a bridge under the influence of repeated hammer blows can be acquired by considering the somewhat analogous case of a spring-supported load, acted upon by a periodic alternating force. Imagine, for instance, a mass suspended from a vertical helical spring. If displaced vertically above or below its position of statical equilibrium and then released, the mass will perform vertical oscillations having a definite frequency depending on the strength of the spring and the mass it supports. Let n denote this frequency measured in oscillations per second, and let the mass be subjected to the influence of a periodic force alternating N times per second. Then when N is less than n, the oscillations are in phase with the applied force, and when the force pulls downwards the spring elongates. If N is greater than n, the oscillations are antiphased to the applied force, and while the force is acting downwards the suspended mass is moving upwards and *vice versa*. When $N=n$ a condition of resonance or synchronism is established, and, in the absence of damping, the oscillations will mount up to an infinite extent.

In this behaviour of the spring-supported mass there is something almost human; it objects to being rushed. If coaxed gently, and not hurried too much, it responds with perfect docility; but if urged to bestir itself at more than its normal gait, it exhibits a mulish perversity of disposition. Such movement as it makes under this compulsion is in a retrograde direction, and the more it is rushed the less it condescends to move. On the other hand, if it is stimulated with its own natural inborn frequency, it plays up with an exuberance of spirit which may be very embarrassing.

But as an explanation of the behaviour of a railway bridge under the influence of the hammer blows of a locomotive this analogy with a loaded helical spring is very far from being complete. A bridge certainly has some resemblance to a spring, but, unlike a loaded helical spring, it possesses an infinite variety of modes of vibration, each of which has its own natural frequency, depending upon the mass and stiffness of the bridge and the loads it may be carrying. The fundamental mode of vibration—that is, the one having the lowest natural frequency, and the only one which is likely to be stimulated into activity by the hammer blows of a locomotive—approximates very closely to a simple sine curve having the equation $y=A_1 \sin(\pi x/l)$, where y is the vertical deflection at a section distant x from an end of the bridge, and l is the length of the span. The natural frequency n of this fundamental mode of vibration is given approximately by the formula

$$2\pi n=\frac{\pi^2}{l^2}\sqrt{\frac{E\,I\,l}{M}}$$

where M is the total mass of the bridge and I is the relevant moment of inertia of its mid-cross section.

If the bridge supports a mass m at a section distant a from an end of the bridge, the fundamental frequency is reduced, and the formula for determining its value introduces both m and a.

Other normal modes of vibration exist, approximating to the forms $y=A_2 \sin(2\pi x/l)$, $y=A_3 \sin(3\pi x/l)$, &c.; but the natural frequencies of these are so high that their influence on the oscillations induced in railway bridges is quite negligible. Owing to practical limitations, the frequency of the hammer blows can never by any chance attain these high values, and for hammer blow a frequency of 6 oscillations per second is, broadly speaking, the upper limit. Consequently, even when the span is as great as 300ft., and the locomotive is travelling at its highest possible speed, synchronism with the higher modes of vibration of a railway bridge can never be achieved, and the only form of resonance possible is that which occurs when the hammer blows synchronise with the fundamental frequency of the bridge. Under these circumstances large oscillations will be induced, and the form in which the bridge then oscillates will approximate very closely to a sine curve of the general type $y=A_1 \sin(\pi x/l)$.

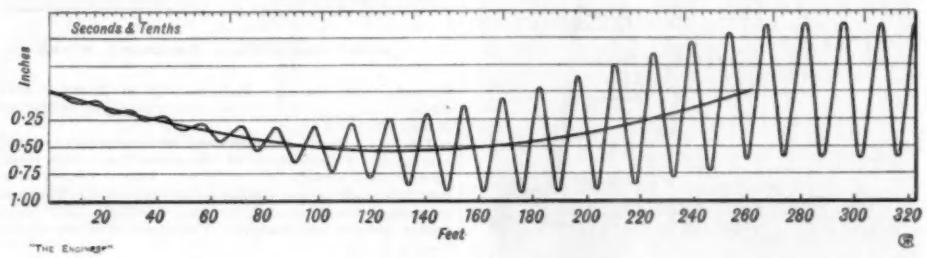


FIG. 1

For short-span bridges, synchronism, even with the fundamental mode of vibration, is out of the question; while, on the other hand, for long-span bridges synchronous oscillations will only be developed at comparatively slow speeds, and in such cases a speed limitation may be positively harmful. For medium-length bridges of 120ft. span or thereabouts the fundamental frequency is of the order 6 periods per second, and resonance will be developed when a locomotive is running, more or less, at its highest speed, and giving hammer blows of maximum intensity. Accordingly, in the case of railway bridges of this medium span class, provision must be made for oscillations of exceptional severity.

The analysis of bridge vibrations is considerably complicated by the fact that the hammer blows producing the oscillations are moving along the bridge, and a most powerful and elegant method of taking this motion into account is provided by the process of harmonic analysis. By this method any distribution of live load, concentrated or distributed, can, for purposes of calculating deflections, be replaced by an harmonic series of sinusoidal distributions of load, the general form of the series being $W_1 \sin(\pi x/l)+W_2 \sin(2\pi x/l)+W_3 \sin(3\pi x/l)+$, &c. Since, for a beam freely supported at its ends, a sinusoidal distribution of load gives rise to a similar sinusoidal distribution of deflection, the simplicity of this process is such that Nature obviously intended it to be employed for calculating deflections.

In general it will be found that the deflection is almost entirely dominated by the primary component or first term of the harmonic series. If the applied force is a hammer blow $P \sin 2\pi N t$ moving with a velocity v along the bridge, then it can be shown that the oscillating effect of this moving force, alternating between the limits $\pm P$, can be viewed as the combined action of two stationary central alternating forces $\frac{1}{2} P \cos 2\pi(N-n)t$ and $-\frac{1}{2} P \cos 2\pi(N+n)t$, having slightly different frequencies $N-n$ and $N+n$. In these expressions $n=v/2l$. In the process of these alternating forces getting into step and out again, the rise and fall of the effectiveness of the force, as it comes on and leaves the bridge, is reproduced with an accuracy which is sufficient for all practical purposes.

For a moving alternating force the oscillations will be pronounced when the frequency of the alternating force coincides with the fundamental frequency of the bridge. Fig. 1 represents the state of affairs predicted by analysis under these circumstances. This diagram gives the deflection at the centre of the bridge, in terms of the position of the force which is producing the deflection. The bridge in question has a span of about 260ft. and a natural

* Abstract of paper read before the Institution of Structural Engineers, October 27th.

frequency of 2·4 periods per second. The load consists of a steady downward force of 100 tons, combined with a periodic force, alternating between the limits ±3·2 tons. The velocity of translation of this combination of forces is about 23 miles per hour, and the frequency of the alternating force being 2·4 periods per second, a condition of resonance is established. It will be seen that, under the stimulus of resonance, the oscillations due to the alternating force mount up to an alarming extent and continue to increase during the whole passage of this force. On the other hand, the effect of the steady force is almost non-dynamical, and the deflection diagram may be viewed as the "crawl deflection" for the steady force, upon which the state of oscillation due to the alternating force is superposed.

Fortunately, this picture is a wild exaggeration of what actually does occur in the case of a railway bridge traversed by a locomotive. It neglects the inertia effect of the mass of the locomotive, and it consequently assumes that a perfect condition of resonance can be maintained between the hammer blows and the fundamental frequency of the bridge, during the whole passage of the locomotive; whereas, in point of fact, this natural frequency changes continuously with the varying position of the moving mass, and true resonance can only be momentarily attained. But the real safeguard which shields railway bridges from excessive oscillations is damping, and any theory which leaves this all-important influence out of account will predict oscillations that have little or no connection with reality. This damping is made apparent and can be estimated by the rate at which free oscillations die down after a locomotive has passed off a bridge. In long-span bridges the rate of decrease is slow; successive deflections decrease in a geometrical series having a common ratio of about 0·9, and residual oscillations persist for a considerable length of time. On the other hand, the damping influences on short-span bridges are so effective that free oscillations die out almost instantaneously. For long-span bridges large oscillations of a synchronous character are associated with comparatively low frequencies, and the vertical accelerations they impart to a locomotive are not sufficient to overcome the friction in its spring movement. Hence for long-span bridges a locomotive in moving across a bridge behaves as though its springs were locked, and in estimating its effect in producing bridge oscillations it is only necessary to know its total mass (excluding the tender), the magnitude of its hammer blow, and the size of its driving wheels. For the bridge the characteristics required are: the span, the total mass, the unloaded fundamental frequency, and the damping coefficient, as deduced from the rate of decrease of residual oscillations.

(To be continued.)

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Trade Situation.

My recent statements in this letter of trade improvements and brighter prospects in the Midlands and Staffordshire are fully supported by the report now issued by the City of Birmingham Information Bureau, which points out that the improvement is reflected not only in one or two industries, but in many of the diverse trades carried on within the city. The communication describes in detail the position in some of the leading automobile engineering works, and asserts that there is a big increase in business in relation to the corresponding period of last year. Thousands of additional hands are now engaged in the industry in this area, and the outlook is encouraging. A firm of tube manufacturers states that its staff is 10 per cent. greater than it was at this time last year, and a section of the factory is working overtime. The manufacture of electric furnaces is forging ahead and the representative of one such company says it has had an exceptionally good year. Moreover, there has recently been a greater volume of inquiries, and the firm is optimistic regarding the future. Many other Birmingham firms of widely separated interests confirm that trade is definitely on the up-grade. The jewellery trade, which is invariably among the first to feel the effects of trade depression and the last to show signs of recovery, is showing signs of improvement. In the imitation jewellery section, one Birmingham firm states it does not know how to cope with the demand; machinery is at present being installed in a large extension to its factory, and overtime is being worked. The manufacture of many other types of goods previously made abroad is finding work for a considerable number of hands. One Birmingham firm is busy making for an American concern safety razors, which, prior to the imposition of tariffs, were wholly imported. The firm is already at work on an order for 25,000, and is in negotiation for an additional factory having a floor space of 25,000 square feet. The manufacture of metal powder boxes and other forms of metal toilet requisites, which was previously the almost entire monopoly of the foreigner, is finding increased employment in Birmingham. One firm has doubled its output during the past year. One of the Walsall leather firms has installed new machinery and is working overtime on the production of a patented form of lady's handbag, while plans are in hand for opening another new department for the making of spectacle cases. Another firm has extended its factory and is working overtime manufacturing toys, many of which were previously imported. It is interesting to note that six firms of foreign origin have already commenced business, or have factory premises under construction in Birmingham. Since the beginning of the year new factories have been opened by British firms for the manufacture of radio valves, metal castings, motor fittings, aeroplane accessories, machine tools and crown corks. A further important commentary on the view now being taken by manufacturers is contained in the report of the Bureau that the principal of a firm of advertising consultants in Birmingham stated they had fixed up an unusually large amount of business during the past month. Manufacturers who have up to now been sitting on the fence, he said, were now launching big advertising campaigns, and there was a general feeling of confidence. It will, of course, be observed that this betterment is to be found chiefly in the lighter trades of the area; but in time it will spread to the heavier industries. Already, as recorded in my letter last week, iron and steelmasters are finding business less restricted and the future is becoming less clouded. There is some revival of enthusiasm and greater confidence in the future. Inquiries to hand are more numerous than they have been of late, and there are good prospects of a substantial reversion of business from the foreigner to the home producer. The buying of Continental material has practically ceased, the prices of foreign material, in many instances, being not now competitive in the Midland market. There has been a little better buying of native steel, but as yet there is no great increase in general volume of business passing. The same remark applies in the case of raw iron. On the whole, there is undoubtedly a leaning towards a revival in trade, and the spirits of industrialists are becoming more blithe. Gloom and melancholy are giving place to hope and enthusiasm.

Pig Iron.

Pig iron producers continue to be dependent mainly upon the flow of trade in the smaller foundries, there being little increase in activity at the engineering foundries in this area. Specifications have been better this past week, and some forward buying of foundry grade material has taken place. Makers of domestic heating and cooking stoves are consuming a fair amount of material, but founders report a slow call for builders' material. In these circumstances, the general volume of raw iron consumed does not grow very noticeably. Nevertheless, Midland blast-furnacemen consider prospects to be more encouraging and there is a brighter tone in the market. Derbyshire and Northamptonshire smelters have stocks in their yards larger than they would like, and at the moment output is, if anything, in excess of demand. The orders received, though numerous, are for small tonnages, and it is reported that in the present state of trade the bulk of the orders are too small to share in the rebate concessions granted to customers who can buy in large quantities. In spite of the continued slackness at the forges in this district, the brighter market tone is shared in that branch of the raw iron trade. Blast-furnacemen have available adequate supplies of furnace coke, values of which remain steady despite the larger call upon ovenmen at this season of the year. Midland pig iron prices are maintained by the Central Pig Iron Producers' Association on the basis of £3 6s. for Derbyshire No. 3 foundry, and £3 2s. 6d. for Northamptonshire, with forge grades 5s. per ton less in each case.

Staffordshire Iron.

In the Staffordshire finished iron trade the mills are working below capacity. Business is of a hand-to-mouth character, and orders are keenly competed for. Though there is a regular demand for marked bars, makers have no reserve of orders, and they are unable to plan ahead. Fortunately, they have no outside competition of any consequence to meet, and they are able to uphold the selling price of their material at £12 per ton. Producers of Crown bars report very poor trade. Competition from makers in other districts is very keen, and the prices quoted by local houses are sufficiently in advance of those of their rivals to justify users, who are not particular as to having first-grade quality, neglecting their local suppliers and going further afield for their material. If there were a standard quality for "Crown" iron, Staffordshire makers assert a different complexion would be put on the market, and they would secure a much larger volume of trade. As things are at present, however, they cannot afford to sell superior material at the same price as outsiders ask for their bars. Common bars for the nut and bolt and fencing trades are, perhaps, a little quicker of sale. Prices of Belgian No. 3 iron, though very appreciably dearer than a few months back, are still some way below those of district makers, and at date there does not seem much prospect of Staffordshire ironmasters wresting this trade from the foreigner. Consuming works in the Darlaston area say they cannot afford to pay for local bars if they are to compete with their rivals in the open market with the finished goods. In some instances, of course, British material is stipulated for bolts and nuts, and in that case makers are compelled to buy locally. For nut and bolt bars of Staffordshire make they pay £8, and for fencing bars £7 15s. Producers of iron strip have increased their output slightly in recent weeks, and demand keeps up reasonbly well. Prices are maintained at £10 7s. 6d. to £10 10s. per ton delivered.

Galvanised Sheets.

Galvanised sheet mills are doing fairly well at the moment, and makers are optimistic as to forthcoming events. In the home trade the market is settling down to the new arrangements under which prices are graduated in accordance to the tonnages ordered, and new business is being received. Makers have made no alteration to the scale of prices as ruling a week ago. In the overseas trade, business is improving, orders being more numerous and, in many instances, of larger capacity. No results have yet been forthcoming from the provisional agreements with India, but galvanised sheet makers hereabouts are sanguine about the recovery of lost ground in this market which, in the past, has been one of first importance. For many years India was one of the biggest buyers of galvanised sheets, their purchases from this country running into millions of pounds per annum. She cannot to-day supply all her own needs, and the agreement, if ratified, will place British makers on a better footing to secure the business available than their Belgian rivals. These latter have been taking the greater proportion of the work in recent years, but there are chances of a reversal of the order in the future. It is believed that a very important avenue of trade is being opened out, and there are expectations of good business from that quarter.

Steel.

Steel works in this area are doing slightly better, for it appears that some business which, in the past, has been going to overseas producers, has been diverted to local steel works. The tonnages are not very large, but this is chiefly owing to the poor state of consumptive requirements. The motor trade is taking good quantities of special classes of steel, and of strip, but the call for structural material remains small, indeed. Steel for the rolling stock industry is, likewise, slow of sale. While prices of native finished steel remain unchanged, values of Continental material have appreciated until, at date, in the case of angles, joists and plates, the difference is quite narrow, while for certain denominations of plates there is no advantage at all in buying foreign. In the half-products branch prices of billets and bars are such as to have no advantage at all to the foreigner. Even so, the market has not yet made up its mind that the advantage of buying abroad has finally passed. Some consumers are looking round for alternative sources of supply at home, and inquiries are in circulation. At the moment, however, they have no need to buy as they have fairly extensive supplies of foreign material, either in stock, or to be delivered against old contracts. No doubt, if the present conditions are maintained, local mills will do more business, but those who have relied upon foreign raw material hesitate to commit themselves to the purchase of native material until they are quite satisfied that the position is not just a passing phase. The appreciation of foreign billets caused Staffordshire re-rollers to increase their prices for re-rolled bars, but there has been no advance on the week, quotations continuing in the region of £6 15s. per ton. Native billet prices are as a week ago, as are values of sheet bars.

Coal Carbonisation.

Interesting developments in the coal carbonisation industry are, I am given to understand, about to take place in the Midlands, as the result of research work which has been carried out during the past three years at the coal distillation plant at Cannock. These investigations are stated to have proved beyond doubt that oil can be produced on a commercial scale, and I learn that Cleveland Securities, Ltd., which controls the business at Cannock, has now called for tenders for the construction of a refining plant to deal with the coal oil. This plant will be capable of treating 100 tons of distillate per day, and it is expected that the motor spirit produced directly from non-coking Cannock coal will be on sale in the Birmingham district within three months of the commencement of the erection of the refining plant. It is believed that this is the first instance of a refining plant being erected in this country to deal solely with the oil produced from non-coking coal.

Contracts.

Several local firms will be better employed as the result of contracts recently received from the Egyptian State Railways. Bayliss, Jones and Bayliss, Ltd., of Wolverhampton, have an order for aerial line material to the value of £172; Thomas William Lench, Ltd., of Blackheath, are to supply £946 worth of goods, and the General Electric Company, Ltd., of Birmingham, £210 worth.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

Engineers and Cheap Capital.

ENGINEERING trade prospects in relation to cheap money rates are referred to by the Manchester Chamber of Commerce monthly record in the course of a review of business conditions. Sections of the engineering trade, it is stated, were in a more hopeful mood in the early part of October. The cotton weavers' strike had held up some business which it was thought would be placed soon, and hopes were entertained that the restrictions on new issues would be lifted at an early date, in view of the marked success of the 5 per cent. War Loan conversion scheme. Before October was a week old, a Middlesbrough company was in negotiation for the contract to erect a bridge 2 miles long and costing something like £2,000,000, for the Danes, and other firms thought their own prospects would be improved when more capital, at low interest rates, was made available for investment. Motor-building, however, was discouraged to some extent by the rise in the price of petrol, and still more by the possibility of taxation being increased, as recommended in the report of the Salter Conference to the Government. Radio engineers showed exceptional enterprise, and were generally well rewarded. Locomotive builders had few important orders to report, and textile engineering continued dull, but electrical engineers appeared to be doing fairly well.

Suspending Ferro-manganese Production.

The announcement was made at the week-end of the temporary closing down of the blast-furnace plant at the Mostyn Ironworks, Flintshire, owing to the heavy accumulation of stocks. The factory is one of the relatively few in this country engaged on the production of ferro-manganese, and had only been in operation since last February after a previous stoppage of operations at the blast-furnaces which had extended over a period of about two years. Approximately, 200 men are affected by the decision to damp down the furnaces. It is understood, however, that operations in other departments at the works are to be continued.

Air Transport Facilities Extension?

Negotiations are in progress between the Airport Committee of the Manchester Corporation and Northern Air Lines, Ltd., the company which operates the air transport services from the Corporation's aerodrome at Barton, a few miles outside Manchester, as the result of which the existing facilities may be extended. This, however, is largely a question of ways and means, and it is mainly with matters of finance that the present discus-

sions are concerned. A special sub-committee has now been set up, and the possibilities will be reviewed in a report which is to be prepared.

Non-ferrous Metals.

Although there has been no particularly encouraging feature from the point of view of trade demand, prices of all descriptions of non-ferrous metals are appreciably higher at the moment of writing than they were a week ago. Up to the end of last week values were not much different from those last reported, the improvement on balance having occurred in the early days of this week. Inquiry in the copper section has been very moderate, and no big weight of business has been placed by any branch of the consuming trades. Quotations for standard brands, however, are not far short of £3 per ton higher than at last report, and the losses in this metal that have occurred since early in October have thereby been made good. A corresponding improvement in prices of refined descriptions of the metal has also occurred. In the case of tin the statistical position shows some improvement, although the extent of this falls below what had been generally expected. The market has not been at all active, but in this section, also, there has been a rise on balance of about £3 per ton, and current prices are higher than they have been at any time since the last upward movement set in early in April. The lead market has had its weak spells during the past week, and in the aggregate no more than a moderate tonnage of the metal has been bought. There has, however, been a rise in prices to the extent of about 10s. per ton. Buying interest in spelter has been less active, but here, also, the early days of the present week witnessed an advancing tendency, in this case values being dearer by nearly 10s. per ton.

Iron and Steel.

Up to the present, the Lancashire iron and steel markets have not participated in the definite improvement that has been reported from certain other centres, although the tone of the market this week has been less depressing. There has been no expansion of forward buying, either in the iron or steel sections; but, generally speaking, the tonnage moving into consumption has been up to the average of last month, and in some instances there is a disposition among speciality firms to call for somewhat bigger quantities. In the foundry iron market forward buying is restricted and the probability now is that users will continue to limit commitments to near delivery dates, at least, until after the turn of the year. Prices are steady, with Derbyshire and Staffordshire No. 3 quoted for delivery to users in the Manchester price zone on the basis of 67s. per ton, Northamptonshire at 65s. 6d., Derbyshire forge iron at 62s., Scottish No. 3 at about 83s. 6d., and West Coast hematite at round 81s. There is a quiet demand about for bar iron, with prices maintained at £9 15s. per ton for Lancashire Crown quality bars, and 10s. extra for best bars. In the steel trade a little more business is passing in certain directions, but in constructional and locomotive engineering the position remains much as it has been for some time. At the moment machine tool makers in this district are poor buyers of special steels. Sellers of the latter, however, have, in some cases, been doing a little better among textile machinists. Small re-rolled bars are firmer in tendency at a minimum of about £7 per ton, with boiler plates at about £8 10s. for acid and basic sorts, joists at £8 15s., sections at £8 7s. 6d., ship and tank plates at £8 17s. 6d., and large diameter bars at £9 7s. 6d.

BARROW-IN-FURNESS.

Hematite.

Business in the hematite pig iron market continues to be steady, but there is no evidence of much improvement as yet. The home requirements are small at present, and buyers are only taking sufficient to keep themselves going. They are not buying to stock, neither are they inclined as yet to place orders of any bulk for future delivery. There is some business doing with the Continent, but it is only on a small scale. Given a general improvement in trade, the Continental demand, as also the American inquiries, should be substantial, with the exchange as it is. There is talk of more activity locally, and as stocks have come down at works it is not unlikely that a furnace or two will be put in blast in the course of the next few weeks. The iron ore trade continues to be quiet, and there is not much doing at some of the mines in the district. There are rumours of certain setbacks at some local mines, but there is no official statement to confirm this at present. The steel market continues to be dull, but a few orders are held, and there may be a restart in the rail department of one of the works shortly. The hoop and small section mills are engaged, and as regards the hoop section business continues to be satisfactory. No doubt the exchange is benefiting this department, not only in regard to America, but elsewhere.

SHEFFIELD.

(From our own Correspondent.)

Finished Steel Activity.

ALTHOUGH the heavy and crude steel branches of local industry remain in a condition of acute depression, there are welcome signs of improvements in the finished steel sections. Certain firms with speciality manufactures needed for the newer industries are fairly well occupied. Some good orders are in hand for steel parts for the motor car industry, and a substantial amount of work is being done in the manufacture of hand and engineers' small tools. At at least two works alloy steels are being made for Russia, and some satisfactory orders have just been placed in the district for heavy stampings, springs, &c. But work is very scarce at the rolling mills on ordinary lines of steels. There is also very little railway work in hand. British and foreign railways have been ordering very little recently, but as stocks must be nearing a minimum, it is reasonable to expect more work in the future.

Improved Production.

Statistics now available show that outputs in the steel trade of Sheffield and Lincolnshire increased appreciably during the month of September. In Sheffield production of steel ingots and castings amounted to 64,300 tons, compared with 45,000 tons in August and 61,600 tons in the corresponding month of last year. Of this latest total, however, only 18,700 tons consisted of acid steel. Production in Lincolnshire increased from 29,500 tons in August and 30,100 tons in September last year to 34,400 tons in September this year. Also Lincolnshire produced in September 37,900 tons of pig iron, compared with 35,600 tons in August and 31,000 tons in September last year.

Aeroplane Engine Parts.

In the manufacture of "Hiduminium" aeroplane engine parts, considerable progress is being made by the Sheffield firm of George Turton, Platts and Co., Ltd., which announces that it is to embark on a programme that will keep the big 5½-ton drop stamp for the making of large aeroplane crank cases operating day and night all next year. Another encouraging statement by this firm is that its output during the past three months has been 20 per cent. more than that of the corresponding three months of last year.

Stainless Steel Progress.

Manufacturers of stainless steels continue to do good business, and the number of adaptions and uses of their material continues to grow. An interesting and important report is expected shortly on tests of stainless steel, which have been carried out during a long voyage of a liner. Experiments on the suitability of stainless steel for marine purposes have been concluded, and it is understood that the results are extremely satisfactory, and may lead to more work coming to the local manufacturers. At present experts are examining the fittings which were subject to the test of the lengthy voyage, and it is understood that comparisons with similar ordinary steel fittings are extremely favourable for the stainless products.

Stainless Steel Hotel.

Considerable interest has been aroused locally in the news of a project to erect at Blackpool a £750,000 hotel, which will be encased with stainless steel. The hotel, to be known as the Sun Ray Hotel, has been designed by Mr. J. Massey, a Sheffield architect, and it is hoped that Sheffield stainless steel will be used in the building. A great amount of this material will be needed to cover the exterior surfaces, for the hotel is to have thirty-nine stories and a tower rising to a height of 420ft. Importance is attached to the subject as the proposed building is said to be the first of its kind in the British Empire, and no doubt will attract widespread attention to this use of stainless steel.

Steel Props in Pits.

It is stated that at the present time there are 75 miles of roadway in Yorkshire coal mines supported by steel arches and 13 miles supported by steel camber bars. Mr. E. H. Frazer, Divisional Inspector of Mines, is a supporter of the policy of adopting more generally in pits the use of steel supports. He favours the use of rigid props with some provision so that they may be drawn easily by means of suitable appliances. One of these appliances has been invented by a Wakefield man, and can be used for both steel and wooden chocks, whilst a device invented by a South Yorkshire miner is now being perfected by a well-known Sheffield steel firm, but is not yet on the market.

Busy File Factory.

It is reported that the file factory of the English Steel Corporation at Holme-lane, Sheffield, is fully employed, overtime work being necessary on occasions. The capacity of this factory, which was laid down in 1920, and since has been extended gradually, is about 5000 dozens of finished files per week. Modern methods of manufacture are employed, and the factory is favourably situated in regard to supplies of steel blanks from the Vickers works of the English Steel Corporation, which also supply the special tools, cutters, and engineering equipment required. Files and rasps of all kinds are manufactured.

Lighter Industries.

A few good orders are in hand locally for high-class cutlery and best silver and electro-plate. In ordinary lines there is a fair amount of Christmas seasonal trade in the works, but the total is far below the normal level, and it is complained that prices are unsatisfactory. The output of safety razors and blades has reached an amazing total. The Wardonia works of T. Ward and Sons have orders which will last for months ahead, and are making excellent progress in overseas markets, particularly in Canada. The booming trade in this section is resulting in a big demand for steel strip.

Road Surfaces Experiments.

Under the observation of a Committee appointed by the Ministry of Transport, experiments in road surface treatment and other road tests are being carried out in Sheffield. It is stated by Mr. W. J. Hadfield, Sheffield City Engineer, that in 1924 there were about 349,000 super yards of asphalt in the city, whilst to-day there are about 1,313,253 yards. In 1920 there were 1,000,000 yards of tarmacadam which has since been laid in large quantities, it being believed that tarmacadam (or bituminous macadam) and certain asphaltic surfaces which have survived every reasonable test, will during the next decade be the principal road-surfacing materials used. Progress has been made with regard to the drainage of road foundations.

Doncaster Schemes.

The Doncaster Town Council is putting in hand certain work for the prevention of floods in districts which suffered severely recently, and the authority has accepted tenders for this work by Edcaster, Ltd., Doncaster (£2527), and Knights (Contractors), Ltd. (£13,860). At the Doncaster aerodrome it is proposed to create an even surface of about 11 acres, upon which aeroplanes may alight, in about two years' time. In connection with this scheme, a tender of £6926 by Swift Brothers and Haslam, Ltd., has been accepted.

NORTH OF ENGLAND.

(From our own Correspondent.)

Coal-Petrol Developments.

IMPORTANT developments to commercialise the production of petrol from coal are expected in the near future at the Billingham-on-Tees works of Imperial Chemical Industries, Ltd. I understand that a company, with a capital of several millions, will exploit the new industry. For some time experiments have been carried out on a small scale at Billingham for the extraction of motor spirit from coal. Until recently it was impossible to produce the spirit on a commercial basis, but this, it is understood, has been successfully overcome, and the experimental plant at Billingham will be considerably enlarged to deal with considerable quantities of spirit. For a long time the motor transport at the Billingham factory of Imperial Chemical Industries, Ltd., has been run on synthetic spirit. The use of Durham coal for this purpose has been found entirely satisfactory, and it is expected, if the present scheme is successful, that it will mean a big fillip to the Durham coalfields. The romance of Billingham appears to have no end. Beginning with the manufacture of nitrates for explosives, Imperial Chemical Industries have developed the production of fertilisers on a large scale, a new substitute for ice, and a plaster-like marble which is now in good demand for building purposes. The discovery of an anhydrite mine beneath the factory has resulted in facilitating these industries. The Billingham factory began as a small experimental station on a farm on the present site. It now covers an immense acreage and is probably the most up-to-date chemical factory in the world.

Brighter Outlook.

There is a much brighter tone in the iron and steel trade of the North of England, and there is a confident feeling that the industry is on the threshold of a period of greater activity. The actual improvement in the volume of business is only slight, but more favourable conditions have been created by the conclusion of the Ottawa Agreements, which have opened the door to increased trade with the Dominions, while the extension of the period of operation of the import duties on foreign iron and steel has created a feeling of confidence, which is reflected in the growing volume of inquiries for material now being received by producers in this area from home consumers.

Cleveland Iron Trade.

Sales of Cleveland pig iron are still somewhat restricted, but the fall in sterling has reopened markets on the Continent, and a few export orders have been arranged. Stocks are not large, and have virtually ceased to increase, but the position is not such as to warrant any increase in production. Makers accept specially low prices from firms in Scotland, and it is understood that overseas business can be arranged at a little below the following fixed minima for home trade:—No. 1 foundry, 61s.; No. 3 G.M.B., 58s. 6d.; No. 4 foundry, 57s. 6d.; and No. 4 forge, 57s.

Hematite Pig Iron.

Orders for East Coast hematite pig iron are unobtainable, except on terms that entail loss to producers, who are not disposed to sell extensively ahead at current prices. South Wales steel makers are again contracting for supplies from this area. Mixed numbers of hematite are quoted at 59s., and No. 1 quality at 59s. 6d.

Iron-making Materials.

Conditions in the foreign ore trade do not admit of business of consequence. Consumers have considerable stocks, and are heavily bought at much higher figures than are now named. Recognised market rates are based on best Rubio ore at 14s. 6d., c.i.f. Tees, but quotations are all but nominal, and contracts for supply over a period could not be arranged at anything like the terms mentioned. Good medium blast-furnace coke is weakly held, and in good supply at 14s. 6d., delivered to works in this area.

Manufactured Iron and Steel.

Finished iron and steel prices are all unchanged, and although there has been no great acceleration of business as yet, negotiations for some big contracts at home and abroad are now in progress. Bridge-building steel is steadily taken up. Producers of railway material have contracts to complete, and may secure a good deal of new work in the near future, but demand for shipbuilding requisites is almost confined to material for repair work. Sheet makers are busier, and hope to secure some further substantial orders.

Iron and Steel Imports.

A slight increase in the amount of iron and steel imported into the river Tees is revealed in the returns issued by the Tees Conservancy Commissioners for October. During the month the imports totalled 7484 tons, whereas in September the total amount was 6485 tons. October's total is made up of 6648 tons of crude sheet bars, billets, blooms, &c., as against 5937 tons in

September, 272 tons of pig iron as against 10 tons, and 564 tons of plates, bars, angles, rails, &c., as against 538 tons. The total amount of iron and steel imported during the past twelve months is 126,522 tons, as compared with 172,437 tons for the corresponding period of 1930–31, and 54,564 tons in the pre-war period of 1913–14. It is interesting to note that since the imposition of tariffs the imports have totalled about 40,000 tons, and during the corresponding months last year 90,000 tons were imported.

The Coal Trade.

The tone throughout the Northern coal trade is much improved. A marked increase in the number of inquiries causes some sellers to take an optimistic view, and it is generally anticipated that the next few weeks will show a substantial improvement in demand. The position in the Northumberland steam coal section is steadily held for early shipment dates, all the favourite brands being substantially booked, but for the end of November supplies of some descriptions are offering freely. Fitters maintain recent prices, but contractors are somewhat eager to clear, and offer slight concessions. In the circumstances, there is a disposition among buyers to hold off and content themselves with practically day-to-day requirements. Best Northumberland steams are firm at 13s. 9d. to 14s. for prompt, but are offering readily forward at 13s. 7½d. to 13s. 9d. Tyne primes are firm under limited supply at 13s., and good grade seconds remain steady at 12s. 3d. Prime Wear steam are nominally steady, but there is no shortage of supply, with best sorts at 15s. and small at 11s. There is no special feature to record in the Durham coal trade. All descriptions of gas coal are in ample supply. Best qualities are quoted at 14s. 6d. and secondary at 13s. to 13s. 6d. First quality unscreened bunkers command 14s. for spot shipment, with forward at 13s. 6d. to 13s. 9d. Secondary bunkers are easy at 13s. Shippers hold several contracts for the early supply of bunker coal to the West Indies, and additional business is under negotiation. Gas coke output is fully taken up, and only odd small parcels are offered on the market at 18s. 6d. Pressure for vertical coke is fully maintained, and sellers can readily obtain 23s. Patent oven coke offers freely, with the undertone a shade easier at 15s. to 15s. 6d. Coke nuts for the United States are in better request, tonnage having been placed to load a cargo of 3500 tons, while other orders are on the point of maturing.

Coal Trade Figures.

An improvement in the coal trade is indicated in the ascertainments for Northumberland and Durham, which nominally govern the wages of miners payable during November. The report for Northumberland shows an available surplus for September of 1·11 per cent. above basis, compared with 6·02 per cent. below basis in the previous month. As 40 per cent. is the minimum wage, the amount to be made up by the owners is 38·89 per cent. The Durham ascertainment shows an available surplus of 28·44 per cent. above the basis, an increase of 3·54 per cent. on the preceding month. The minimum for the county being 65 per cent. on the basis, the owners are required to make up the deficiency of 36·56 per cent.

SCOTLAND.

(From our own Correspondent.)

Outlook Improving.

Since the tariff arrangements have been fixed for a period of two years, greater confidence has become apparent in the steel and iron trades. Makers are fully alive to the possibilities of the situation created and will make every effort to satisfy the conditions annexed. With the rising tendency of Continental prices, combined with the import duties and the depreciation of the pound, the position is most favourable, and there is little doubt that preparations will speedily be made to take full advantage of the opportunity thus offered.

Shipbuilding.

A considerable time has passed since three orders were placed with Clyde yards within one week. Messrs. Denny of Dumbarton have received an order for a first-class passenger turbine steamer, to be ready for service on the Clyde next summer, and a day or two earlier the same firm booked an order from the Southern Railway for a passenger steamer. The third order is one for a passenger and cargo steamer for the Bombay Steam Navigation Company, to be built at Govan by Harland and Wolff.

Steel.

Scottish steel makers have benefited to the extent of some 12,000 tons from the orders for plates placed in this country by the Soviet Government. Makers are also in receipt of some small specifications for shipbuilding material on home account, and in all probability these will increase in number and quantity in the near future. Steel sheets maintain their improvement, with heavy gauges becoming more prominent, and it is expected, now that Continental prices are non-competitive, increased improvement will be registered. Some firms producing light sheets are working at full capacity. Steel tubes are meeting with a better demand for butt-welded and large diameter descriptions.

Iron.

The demand for hematite and ordinary pig iron has not improved so far, and is easily satisfied from stocks. Last week 1750 tons of pig iron arrived from India, and 350 tons from Workington. Owing to dearer costs of raw materials makers of re-rolled steel bars have raised their prices from £6 10s. to £7 5s. per ton for home delivery, and from £6 5s. to £6 10s. per ton for export. In all probability producers will have to rely on home sources for their supply of billets. Re-rollers have been a little better employed during the past week or so.

Scrap.

The market for scrap is still easy, with heavy steel about 35s., and cast iron machinery at 42s. 6d. to 45s. per ton.

Coal.

Foreign demands for coal have become more restricted since prices began to move upwards, but the present turnover might have been larger if the necessary fuel had been available. In the East of Scotland, and particularly in Fifeshire, pits have been closed and shifts reduced in order to avoid over-production under the quota. Fifeshire and Lothians' steams are scarce and firmer. Nuts are firm in both areas, and singles and pearls are now difficult to obtain, shipments of these having been more prolific of late, especially to the Thames. Aggregate shipments during the past week amounted to 261,896 tons, against 255,109 tons in the preceding week, and 237,638 tons in the same week last year.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

The Coal Trade.

Returns of coal and coke shipments from the main ports in this Channel last week were fair, but rather disappointing. The total, according to the Great Western Railway Company's statistics, came to 412,525 tons, which compared with 420,435 tons for the preceding week. There is, however, this satisfaction that the quantity compared very favourably with the corresponding period of last year, as the total then was only 361,709 tons. It is quite possible that shipments as a whole would have been better but for the fact that tonnage, as the result of bad weather, failed to be ready at the expected time. Still, so far as Swansea was concerned, it is questionable whether better work could have been done, as throughout the whole week there was more tonnage in dock than could be dealt with. In fact, many steamers which in the ordinary course would have loaded at Swansea were ordered to adjacent ports, mainly Port Talbot, in order that a quicker turn might be secured. According to a return issued by the Swansea Chamber of Commerce, it was estimated that steamers which would have loaded about 40,000 tons of cargo and 2500 tons of bunkers were diverted from Swansea. Still the dock returns showed that at the end of last week six steamers were waiting to get into berth at Swansea, while as the result of week-end arrivals the position on Monday was that eight vessels were waiting. As a matter of fact, the situation on Monday was more favourable from the colliery point of view at all the ports. Whereas on Saturday there were thirty-three idle tipping appliances at the docks between Newport and Barry, the position on Monday was that this figure was reduced to seventeen, which was much better than has been the case for many weeks past.

The Foreign Demand.

Now that it has been announced that the Government is giving close attention to the representations made by the coal trade that negotiations should be opened up with importing countries which are placing a barrier against coal imports, hopes are entertained that some effort will be made immediately to secure freer conditions as they affect the leading Continental countries. At the moment, business is very featureless, both for prompt and forward loading. The report is to hand that one of the French Railways, viz., the Midi, has bought Durham coals for delivery during the first quarter of next year, but so far nothing is known of any sales ahead having been effected in Welsh coals. It is, however, interesting to note that in the case of Belgium the restriction upon coal imports has been removed in respect of coals below 15 per cent. volatile content. This, of course, means chiefly dry coals, which form the best substitute for anthracite coals. At the moment these coals are very scarce, especially the sized descriptions, so that it is difficult to see how there can be an immediate improvement in the volume of business with Belgium. Still, it is reported that business is being done and tonnage has already been chartered. One is reminded of the loss of Irish business when it is reported that the Great Southern Railway of Ireland has contracted for about 30,000 tons of German coal to be delivered at Dublin and Rosslare principally during the next two months. A certain amount of coal is still going to the Irish Free State from South Wales, but nothing like what would have been the case if there were no 5s. tax on British coal.

Miscellaneous Items.

As the result of discussions between the South Wales coalowners and the Great Western Railway Company on the question of an application to the Rates Advisory Committee, with a view to the Association obtaining a reduction in the charges for tipping and weighing coal and coke at the South Wales ports, an arrangement has been made under which the railway company grants a rebate of ¼d. per ton off the charges to operate as from October 1st last. This means a concession to the colliery companies on the basis of a year's shipments of approximately £50,000. This arrangement is to continue for two years. Coal trimmers at Cardiff, Penarth and Barry decided during the past week-end by a small majority in favour of continuing negotiations with the shipowners on the question of the latter's application for a further reduction in the scale of tariffs payable to the men. The men's side of the Welsh Tin-plate Joint Industrial Council has received intimation that the employers are willing to continue the *ex-gratia* bonus of 7½ per cent. to the lower-paid men for the current quarter. Plans are being pushed forward for the establishment of a metal industry on the site of the old Cyfarthfa Ironworks at Merthyr. They have been advanced as the result of the discovery of a new process for treating aluminium and producing an alloy for which great commercial possibilities are claimed. It is proposed that a company should be formed with a capital of £15,000, the inventors taking a two-thirds interest, the remaining £5000 to be raised by public subscription in 5s. shares. It is stated that the plant will not be very extensive at the start, but developments are likely to provide employment for a large body of men.

Traffic Returns.

Statistics issued by the Great Western Railway of the traffic at the six ports in this area under its control show that for the four weeks ended October 23rd imports and exports combined came to 1,985,200 tons, which was a slight improvement upon the preceding month, though it compared with 2,190,674 tons for the corresponding period of last year. Taking the returns for the whole of this year to October 23rd, the total comes to 21,132,596 tons, as against 22,684,814 tons, so that the decline in trade for practically ten months amounts to just over 1½ million tons. One noticeable feature is that the imports of iron and steel have declined by 134,200 tons, while on the export side coal shipments have fallen off by 1,155,000 tons. In the case of Swansea and Port Talbot, coal shipments expanded by 332,000 tons and 189,000 tons respectively, but at Cardiff, Penarth, Barry, and Newport there was a substantial reduction.

Current Business.

Market conditions from day to day have been almost featureless, except that merchants have found it practically impossible to secure prompt supplies of sized coals, particularly of the dry description. Large coals meet with comparatively small inquiry. Patent fuel is very steady and coke moves off pretty freely, but pitwood remains without change at about 21s. 6d. to 22s. 6d.

CONTRACTS.

J. Samuel White and Co., Ltd., East Cowes, I. of W., has secured the order for the main propelling turbine machinery for the British sloops "Grimsby" and "Leith," building at H.M. Dockyard, Devonport.

The Atlas Diesel Company, Ltd., has received an order from John I. Thornycroft and Co., Ltd., Southampton, for a twin-screw set of marine Diesel engines to develop in service 1740 B.H.P. at 250 r.p.m. These engines will be installed in a large yacht.

Harland and Wolff, Ltd., inform us that they have received an order from the Bombay Steam Navigation Company, Ltd., for the construction of a twin-screw passenger and cargo vessel. The ship will be about 200ft. long and have two sets of triple-expansion engines. The hull is to be constructed at the Govan shipyard and the machinery at the firm's Belfast works.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

At a board meeting of Worthington-Simpson, Ltd., held on October 12th, Mr. A. Burgess, general sales manager, was elected an additional director. Mr. Burgess has previously represented the company's interests in Brussels, Paris, Buenos Aires, &c.

The "R.N." Diesel Engine Company, 24, Harrison-street, London, W.C. 1, informs us that Mr. Da Costa, of Lisbon, has ordered from it a three-cylinder marine "R.N." high-speed Diesel engine for his yacht, and that Mr. D. M. Van Renan, of Barcelona, has ordered a duplicate set.

Mr. D. J. Thomas, A.M.I.E.E., 2, St. Andrew's-place, Cardiff, has been appointed sole selling agent for Switchgear and Cowans, Ltd., of Old Trafford, Manchester, for the counties of Monmouth, Glamorgan, Carmarthen, Brecon, Cardigan, Pembroke, Gloucester west of the river Severn, and the city of Gloucester.

Sulzer Bros. (London), Ltd., have entered into an agreement with Sir W. G. Armstrong, Whitworth and Co. (Engineers), Ltd., to manufacture exclusively for them and from drawings supplied by them, centrifugal pumps, oil engines, refrigerating plant, &c., at their Scotswood Works, Newcastle-upon-Tyne. This arrangement, however, does not preclude Sulzer Bros. from supplying machinery manufactured in Switzerland as hitherto.

CATALOGUES.

W. H. Allen, Sons and Co., Ltd., Bedford.—Two new publications, A.P. 450, "Allen Electrical Plant"; A.P. 400, "The Conqueror 'Omniduktor' Unchokeable Pump."

Germ Lubricants, Ltd. (formerly Henry Wells Oil Company, Ltd.), 736–739, Salisbury-avenue, E.C.2.—"The Lubrication of Compression-ignition Engines for Road Vehicles."

Vacuum Oil Company, Ltd., Caxton House, S.W.1.—Gargoyle Technical Series, Nos. 12 and 13: "The Lubrication of Refrigerating Machines" and "The Lubrication of Air Compressors."

Morse Chain Company, Ltd., Letchworth, Herts.—Catalogue M.L. 1032, giving details of the design, application, and construction of Morse chain drives of the inverted tooth type, as well as Bush roller chain and the all-metal flexible chain coupling.

EDUCATIONAL INTELLIGENCE.

Imperial College of Science and Technology.—Arrangements have been made by the Governing Body of the Imperial College for the delivery during session 1932–33 of a series of special lectures on several of the productive industries by lecturers whose experience will enable them to speak with authority. The lectures, which will be given in the Mathematics Lecture Theatre in the Huxley Building of the Royal College of Science, Exhibition-road, S.W.7, are open to all members of the College, staff and students. Students especially are advised to attend these lectures. The lectures during the autumn term will be:—(1) By Dr. Herbert Levinstein, on "The Chemical Manufacturing Industry," Thursday, October 27th, at 4 p.m.; (2) by Mr. Austin Hopkinson, on "The Advantages of the Small Industrial Organisation," Thursday, November 17th, 1932, at 4 p.m.; (3) to be arranged, Thursday, December 1st, 1932, at 4 p.m.; (4) by Mr. G. M. Burt, on "The Building Industry," Thursday, December 15th, 1932, at 4 p.m. Particulars of the lectures during the spring term will be announced later, but they are expected to treat of (a) "The Heavy Engineering Industry," (b) "The Textile Industry," and (c) "The Steel Industry." A volume of the seven lectures will subsequently be published.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. Coast—	
(1) Native	16/6 to 20/–
(1) Spanish	17/– to 23/6
N.E. Coast—	
Native	18/– to 21/–
Foreign (c.i.f.)	14/6

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) Scotland—		
Hematite	3 7 6	—
No. 1 Foundry	3 10 0	—
No. 3 Foundry	3 7 6	—
N.E. Coast—		
Hematite Mixed Nos.	2 19 0	2 19 0
No. 1	2 19 6	2 19 6
Cleveland—		
No. 1	3 1 0	3 1 0
Siliceous Iron	3 1 0	3 1 0
No. 3 G.M.B.	2 18 6	2 18 6
No. 4 Foundry	2 17 6	2 17 6
No. 4 Forge	2 17 0	2 17 0
Mottled	2 16 6	2 16 6
White	2 16 6	2 16 6
Midlands—		
(c) Staffs.—	(*Delivered to Station.*)	
All-mine (Cold-blast)	—	—
North Staffs. Forge	3 1 0	—
„ „ Foundry	3 6 0	—
(c) Northampton—		
Foundry No. 3	3 2 6	—
Forge	2 17 6	—
(c) Derbyshire—		
No. 3 Foundry	3 6 0	—
Forge	3 1 0	—
(3) Lincolnshire—		
No. 3 Foundry	—	—
No. 4 Forge	—	—
Basic	—	—
(4) N.W. Coast—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	3 15 6 (*a*); 4 0 6 (*b*); 4 5 6 (*c*)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
Scotland—		
Crown Bars	9 15 0	9 5 0
Best	—	—
N.E. Coast—		
Iron Rivets	11 5 0	—
Common Bars	9 5 0	—
Best Bars	10 5 0	—
Double Best Bars	10 15 0	—
Treble Best Bars	11 5 0	—
Lancs.—		
Crown Bars	9 15 0	—
Best Bars	10 5 0	—
Hoops	12 0 0	—
S. Yorks.—		
Crown Bars	9 15 0	—
Best Bars	10 15 0	—
Hoops	12 0 0	—
Midlands—		
Crown Bars	9 0 0 to 9 15 0	—
Marked Bars (Staffs.)	12 0 0	—
Nut and Bolt Bars	8 0 0 to 8 10 0	—
Gas Tube Strip	10 7 6 to 10 10 0	—

STEEL. (*d*)

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) Scotland—		
Boiler Plates (Marine)	9 0 0	8 10 0
„ „ (Land)	—	—
Ship Plates, ½in. and up	8 15 0	7 15 0
Sections	8 7 6	7 7 6
Steel Sheets, ¼in.	7 15 0	7 15 0
Sheets (Gal. Cor. 24 B.G.)	11 5 0—10 Ton Lots and Upwards Delivered Glasgow Stations.	10 0 0
„ (Gal. Cor. 24 B.G.)	For Canada	10 15 0

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. Coast—		
Ship Plates	8 15 0	7 15 0
Angles	8 7 6	7 7 6
Boiler Plates (Marine)	10 10 0	—
„ „ (Land)	10 0 0	—
Joists	8 15 0	7 7 6
Heavy Rails	8 10 0	—
Fish-plates	12 0 0	—
Channels	10 5 0	£9 to £9 5s.
Hard Billets	7 2 6	—
Soft Billets	5 10 0	—
N.W. Coast—		
Barrow—		
Heavy Rails	8 5 0	—
Light Rails	8 10 0 to 8 15 0	—
Billets	6 10 0 to 9 0 0	—
Manchester—		
Bars (Round)	9 7 6	—
„ (Small Round)	7 0 0	—
Hoops (Baling)	10 0 0	9 15 0
„ (Soft Steel)	9 0 0	8 15 0
Plates	8 17 6 to 9 2 6	—
„ (Lancs. Boiler)	8 10 0	—
Sheffield—		
Siemens Acid Billets	9 2 6 (basis)	—
Hard Basic	8 2 6 and 8 12 6	—
Intermediate Basic	6 12 6 and 7 2 6	—
Soft Basic	5 15 0	—
Hoops	9 10 0 to 9 15 0	—
Soft Wire Rods	7 10 0	—
Midlands—		
Small Rolled Bars (all British)	7 0 0 to 7 5 0	—
Small Re-rolled Bars	6 15 0	—
Billets and Sheet Bars	4 17 6 to 5 7 6	—
Galv. Sheets	11 5 0 to 12 15 0	10 0 0
(2) Staffordshire Hoops	9 10 0	—
(*d*) Angles	8 7 6	—
(*d*) Joists	8 15 0	—
(*d*) Tees	9 7 6	—
(*d*) Bridge and Tank Plates	8 17 6	—
Boiler Plates	8 7 6 to 8 10 0	—

NON-FERROUS METALS.

Swansea—	
Tin-plates, I.C., 20 by 14 f.o.b.	15/9 to 16/3
Block Tin (cash)	155 5 0
„ (three months)	156 0 0
Copper (cash)	33 2 6
„ (three months)	33 6 3
Spanish Lead (cash)	12 8 9
„ „ (three months)	12 15 0
Spelter (cash)	15 10 0
„ (three months)	15 17 6
Manchester—	
Copper, Best Selected Ingots	37 10 0
„ Electrolytic	38 10 0
„ Strong Sheets	65 0 0
„ Tubes (Basis Price), lb.	0 0 10
Brass Tubes (Basis Price), lb.	0 0 9
„ Condenser, lb.	0 0 11½
Lead, English	14 7 6
„ Foreign	12 15 0
Spelter	15 15 0
Aluminium (per ton—raw ingot)	£95

FERRO ALLOYS.

	Per Ton.	Per Unit.
Tungsten Metal Powder	1/10½ per lb.	
Ferro Tungsten	1/7½ per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£25 15 0	8/–
„ „ 6 p.c. to 8 p.c.	£24 10 0	7/6
„ „ 8 p.c. to 10 p.c.	£22 5 0	7/–
„ „ Specially Refined		
„ „ Max. 2 p.c. carbon	£36 10 0	11/–
„ „ „ 1 p.c. carbon	£42 12 0	14/–
„ „ „ 0·70 p.c. carbon	£44 0 0	16/–
„ „ „ carbon free	1/– per lb.	
Metallic Chromium	2/9 per lb.	
Ferro Manganese (per ton)	£10 15 0 for home	
„ „ „	£9 15 0 for export	
„ Silicon, 45 p.c. to 50 p.c.	£13 10 0 scale 5/– per unit	
„ „ 75 p.c.	£19 10 0 scale 6/– per unit	
„ Vanadium	12/6 per lb.	
„ Molybdenum	6/3 per lb.	
„ Titanium (carbon free)	9d. per lb.	
Nickel (per ton)	£245 0 0	
Ferro Cobalt	7/9 per lb.	

FUELS.

SCOTLAND.

	Export.
Lanarkshire—	
(f.o.b. Glasgow)—Steam	13/–
„ „ Ell	15/–
„ „ Splint	14/– to 16/–
„ „ Trebles	14/6 to 15/–
„ „ Doubles	12/6
„ „ Singles	11/–
Ayrshire—	
(f.o.b. Ports)—Steam	12/–
„ „ Jewel	16/6
„ „ Trebles	15/6
Fifeshire—	
(f.o.b. Methil or Burntisland)—Steam	12/6 to 14/–
Screened Navigation	16/– to 16/6
Trebles	17/– to 18/6
Doubles	13/– to 14/6
Singles	11/–
Lothians—	
(f.o.b. Leith)—Best Steam	13/–
Secondary Steam	12/6
Trebles	15/6
Doubles	12/6 to 13/–
Singles	10/6 to 11/–

(8) N.W. Coast— ENGLAND.

Steams	20/– to 21/6
Household	32/6 to 52/6
Coke	19/– to 22/6
Northumberland—	
Best Steams	13/6
Second Steams	12/3 to 12/6
Steam Smalls	8/6
Unscreened	12/6 to 13/–
Household	27/– to 39/–
Durham—	
Best Gas	14/6
Second	13/3 to 13/6
Household	25/– to 37/–
Foundry Coke	24/–

Sheffield—	Inland.	
Best Hand-picked Branch	27/– to 28/–	—
South Yorkshire Best	23/– to 24/–	—
South Yorkshire Seconds	18/– to 21/–	—
Derbyshire Best House	22/– to 23/6	—
Derbyshire Best Brights	18/– to 20/–	—
Screened Seconds	17/6 to 19/–	—
Kitchen Coal	16/6 to 17/6	—
Best Screened Nuts	17/– to 18/6	—
Small Screened Nuts	16/– to 16/6	—
Yorkshire Hards	17/– to 18/–	—
Derbyshire Hards	17/– to 18/–	—
Rough Slacks	8/6 to 9/6	—
Nutty Slacks	7/– to 8/6	—
Blast-furnace Coke (Inland)	10/– on rail at ovens	
Furnace and Foundry Coke (Export), f.o.b., 14/6 to 15/6		

(9) SOUTH WALES.

Cardiff—	
Steam Coals :	
Best Smokeless Large	19/6 to 19/9
Second Smokeless Large	18/9 to 19/6
Best Dry Large	19/– to 19/6
Ordinary Dry Large	17/9 to 18/3
Best Black Vein Large	18/3 to 18/6
Western Valley Large	17/9 to 18/–
Best Eastern Valley Large	17/7½ to 17/9
Ordinary Eastern Valley Large	17/3 to 17/6
Best Steam Smalls	13/– to 13/6
Ordinary Smalls	11/– to 13/–
Washed Nuts	19/– to 31/–
No. 3 Rhondda Large	19/6 to 19/9
„ „ Smalls	15/– to 16/–
No. 2 „ Large	17/– to 17/3
„ „ Through	15/6 to 16/–
„ „ Smalls	14/– to 14/3
Foundry Coke (Export)	22/6 to 36/6
Furnace Coke (Export)	17/– to 18/–
Patent Fuel	20/–
Pitwood (ex ship)	21/– to 22/–
Swansea—	
Anthracite Coals :	
Best Big Vein Large	36/– to 38/6
Seconds	27/– to 34/–
Red Vein	22/– to 26/6
Machine-made Cobbles	37/6 to 48/6
Nuts	36/6 to 48/6
Beans	28/6 to 32/6
Peas	19/6 to 21/–
Breaker Duff	8/6 to 9/6
Rubbly Culm	9/9 to 10/6
Steam Coals :	
Large	20/– to 20/6
Seconds	18/– to 20/–
Smalls	11/6 to 13/–
Cargo Through	16/– to 17/6

(1) Delivered. (2) Net Makers' Works. (3) f.o.b. Makers' Works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayrshire. (6) Home Prices—All delivered Glasgow Station. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. (*a*) Delivered Glasgow. (*b*) Delivered Sheffield. (*c*) Delivered Birmingham. (*d*) Rebate : Joists (minimum), 22/6 ; Ordinary Ship, Bridge, and Tank Plates and Sections, 15/– if home consumers confine purchases from associated British Steel Makers. (*e*) Delivered Black Country Stations.

French Engineering Notes.

(From our own Correspondent in Paris.)

The Steel Industry.

THE negotiations for renewing the Steel Cartel on the basis of a central distribution of foreign orders which will eliminate competition and keep up prices at a remunerative level are not proceeding so well as had been expected, for there is still one refractory maker outside the Belgian group who refuses to enter the combination, and unless there is complete agreement amongst all steel makers the chances of the Cartel working satisfactorily appear remote. These protracted delays are also changing the situation of steel producers, and while the French are satisfied with the proposed arrangement, the Germans are reported to be less agreeable to an acceptance of the quota allotted to them, so that the effect of the Belgian procrastination may be to bring up the question of quotas again when a meeting is held for the final settlement. Meanwhile the situation of the international steel trade can hardly be worse than it is at present. Prices are certainly hardening and bars are quoted £2 17s. 6d. to £3 a ton f.o.b. Antwerp, but that is because makers find that they cannot continue to work at a loss. In France the unexpected collapse of the strip comptoir has weakened the home steel organisation which was completed some months ago for a restriction of output and a maintenance of prices, and the outlook is not so promising as it was at that time, when the programme of public works seemed likely to create a demand for steel. That programme is still in abeyance. The statistics of the Comité des Forges de France continue to show a big decline in the production of iron and steel, the output of steel in September amounting to 456,000 tons, as compared with 655,000 tons in the corresponding month of 1931 and 808,000 tons in September, 1929.

Port of Verdon.

Work upon the port of call at Verdon, at the mouth of the Gironde, is nearing completion, and the port will be inaugurated in the spring, when passengers will be able to land and embark and be carried by rail to and from Bordeaux instead of making the tedious voyage up and down the river for a distance of 37 miles. It is also intended to shorten the journey for passengers from Central and South America, who will land at Verdon from ships that call there before proceeding to their regular ports. The construction of the landing mole, 317 m. long and 38 m. wide, raised interesting and difficult problems, particularly in connection with the sinking of a hundred concrete piles, 26·5 m. long, which had to traverse a deep layer of fine sand before reaching a clay foundation. The hollow reinforced concrete piles were floated out and sunk by pumping out the sand from the inside and then filling the shells with concrete. The mole carrying four railway tracks, railway station, and a building for Customs, offices, and other purposes, is connected with the mainland by a viaduct. An artesian well has been sunk to a depth of 565 m. for the supply of water to ships and an oil pipe line has been laid out to the mole. Illustrated details of the mole construction were published in THE ENGINEER of September 12th, 1930.

Canal des Deux Mers.

The Syndicate of Public Works Contractors is trying to revive interest in the proposed lateral canal across the South of France, known as the Canal des Deux Mers, by issuing a pamphlet by Monsieur Charles Moreau, who was largely responsible for organising the construction of the Alsace Canal and who reviews the old scheme for a lateral canal in the light of experience gained with recent undertakings. The scheme has been discussed for more than fifty years, since the time when it was proposed to build a ship canal from Narbonne to the Atlantic at a point below the Gironde. The idea was then strategical and was abandoned on account of the difficulties of construction and cost, but of late it has been revived as a commercial undertaking which would divert across France a considerable tonnage of sea-going traffic between the North of Europe and the Mediterranean. Monsieur Moreau has brought the scheme to within more reasonable limits, and claims that by constructing the canal for boats of 2000 tons it could be made a profitable undertaking. He estimates the total cost at rather more than 4000 million francs, including 1055 millions for plant and machinery. Contractors are naturally anxious to include this scheme in the national programme of public works, and they argue that it would be more serviceable as a means of shortening the distance between Rotterdam and the Mediterranean than the Rhone, when that river is connected up with the canals in Holland.

Riviera Water Supply.

The supply of water in the South of France, and particularly along the Riviera, has always presented difficulties on account of the cost of bringing water from long distances, usually from rivers and valleys in the Alps, and it is only of late years that municipalities and other local authorities have been impressed with the necessity of incurring the expense of carrying out these supply works. They are further encouraged to do so by the offer of State subsidies. The water at Nice is obtained by gravity from the river Vésubie and is treated by the ozone process, but there exists in the valley of the Var subterranean water, bacteriologically pure, at a depth of 30 m., which the municipality intends to draw upon to supplement the existing supply and to provide water to surrounding communes. Ten wells will be sunk and the water will be distributed from a pumping station. It is not intended to substitute this supply for the Vésubie water, which is much cheaper. Another important scheme has been sanctioned by the Conseil Général des Alpes Maritimes for supplying water to fifteen communes above Grasse and Cagnes, where water will be taken from some upper tributaries of the Var and, after being filtered and purified, will be pumped into a reservoir of 8000 cubic metres capacity for distribution. The cost of the work will be nearly 20 million francs, covered mostly by subsidies from the Department and the State.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

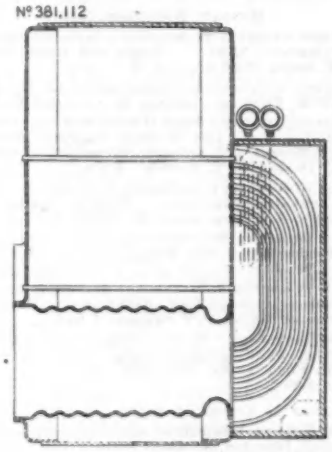
The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

STEAM GENERATORS.

381,112. April 21st, 1932.—MARINE BOILERS, J. Johnson, "Green Shutters," The Highway, Sutton, Surrey.

This marine boiler is put forward as being specially suitable for firing with oil or powdered coal. It is somewhat after the type of an ordinary Scotch boiler, but instead of having internal

Nº 381,112



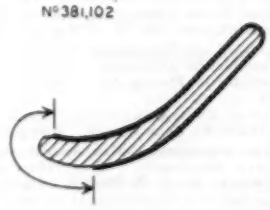
combustion chambers it has an exterior smoke-box lined with refractory material. Inside this box there are arranged water tubes, which more or less partition off the box into three compartments, one for each furnace. There is also a superheater in the upper part of the box.—*September 29th*, 1932.

TURBINE MACHINERY.

381,102. April 1st, 1932.—TURBINE BLADING, *G. R. Shepherd*, 2, *Norfolk-street, Strand, London, W.C.2.*

In order to protect the low-pressure blades of steam turbines from erosion their leading edges are nitrided, which hardens them. The blades are made of a nitrogenisable steel and are nickel-plated all over. The plating is then ground off in way of the

Nº 381,102



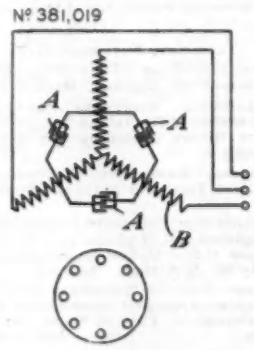
part which is to be nitrided. During the process of nitrification the nickel protects the body of the blade, which is not affected. The cross-sectional illustration shows the nickel-plated part with a thick line. The nitrided part expands slightly during the process, but is held in compression by the body of the blade which remains tough.—*September 28th*, 1932.

DYNAMOS AND MOTORS.

381,019. December 14th, 1931.—POLYPHASE ASYNCHRONOUS MOTORS, Walter John Barthe, of 1215, Josephine-street, New Orleans, Louisiana, U.S.A.

This invention refers to improvements in polyphase asynchronous motors, the chief object being to improve the power factor of these motors. In that form of the invention illustrated condensers A are connected in at intermediate points on the field coils B which are con-

Nº 381,019



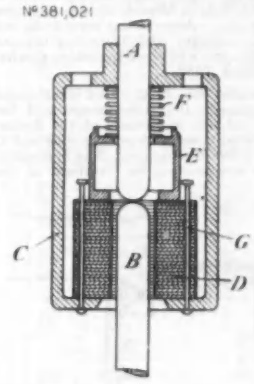
nected in star form. One terminal of each condenser is connected to one coil B and the other terminal to the next adjacent coil, the three condensers being connected across the three phases, as shown. The effect of the condensers is, of course, to tend to cause the current in the field coils to lead rather than lag behind the electromotive force, as they normally do by reason of the inductance in the field coil. —*September 29th*, 1932.

SWITCHGEAR.

381,021. December 15th, 1931.—ELECTRIC SWITCHES WITH ARC EXTINGUISHING CHAMBERS, Aktiengesellschaft Brown, Boveri et Cie., of Baden, Switzerland.

The oil switch described in this specification is of the type having extinguishing chambers. A is the fixed switch contact, B the movable contact, and C the extinguishing chamber. Piled on the bottom of the extinguishing chamber are the metal discs D, which are bored through centrally. The movable contact B moves in the bore of the discs. The member E for applying pressure to the metal discs bears with an interposed compression spring F against the upper end of the extinguishing

Nº 381,021



chamber. The metal discs are threaded on pins G for preventing the discs from being forced away laterally. When the switch is in the closed state the metal discs are pressed together by the spring F and the pressure-applying member E. On the switch being opened the pressure-applying member E is raised by the pressure of the heated gas generated, in opposition to the force of the spring F, and the discs D are relieved of the load. The liberated gases can then pass through between the loosely superposed discs, the metal discs rapidly withdrawing so much heat from the gases that the latter leave the extinguishing chamber greatly cooled down.—*September 29th*, 1932.

TRANSFORMERS AND CONVERTERS.

381,109. April 16th, 1932.—VARIABLE TAPPINGS ON TRANSFORMER AND THE LIKE WINDINGS, The English Electric Company, Ltd., of Queen's House, 28, Kingsway, London, W.C.2, and George Fletcher Stearn, of 65, Lichfield-road, Stafford.

This specification describes a variable tapping device suitable for use, for example, with tap-changing transformers. It is often required to vary the fraction of a winding included between two end connections while maintaining the potential of an intermediate tapping at a fixed point on the potential gradient between the end connections. Frequently the intermediate tapping has to be maintained at the mid-point. If voltage variation is obtained by taps on such a winding it is essential that the number of turns left in circuit on each side of the middle point be always equal. This is shown in Fig. 1, where the mid-points of the three secondaries are all connected together and connected to the tapping A. Variable end tappings are made to each of the three windings respectively. With two sets of variable tappings per winding as shown it is necessary to provide two on-load tap changers per winding, these being connected so as to be maintained in step. The object of the invention is to make the tapping connections so that the conditions required in the above case are met, but so that only one on-load

Nº 381,109

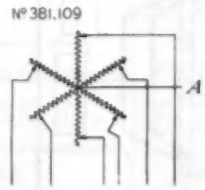


Fig. 1.

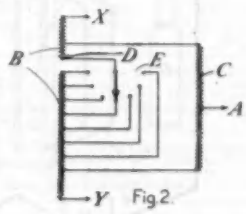


Fig. 2.

tap changer per phase is required. The tapped winding is divided and a second or potentiometer winding is connected between two points equidistant from the ends of the tapped winding, one on each division of the tapped winding. An intermediate tapping connection is made to a point on the second winding. A single tap changer connects one end of one of the divisions to a variable tapping point on the other division, thus varying the number of turns of the tapped winding in parallel with the second winding. The invention is shown in Fig. 2 applied to one of the phase windings of Fig. 1. The winding B is divided into two disconnected sections. The end connections X Y are fixed tappings and not variable, as shown in Fig. 1. A second or potentiometer winding C is connected as shown. The intermediate tapping A is connected to the mid-point of the winding C. The point D is connected to the switch arm of the on-load tap changer E, to which are connected a number of variable tapping points on the winding between, as shown. Thus the tap changer varies the fraction of the tapped winding in parallel with the second winding C and so varies the total voltage between X and Y. At the same time the voltage between X and A is always equal to the voltage between A and Y. The points A on the three potentiometer windings are connected together as indicated in Fig. 1 to form the star point of the six-phase winding.—*September 29th*, 1932.

MISCELLANEOUS.

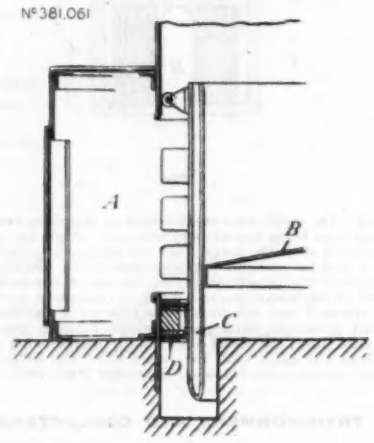
380,677. December 28th, 1931.—ELECTRICAL INSULATING MATERIAL COMPOSED OF MICA, Maschinenfabrik Oerlikon, of Oerlikon, near Zürich, Switzerland.

A known method of employing mica for insulation purposes consists in cementing small laminæ of mica, laid so as to overlap in the manner of roofing slates, on to an endless paper web. Until recently, the adhesive lacquers employed as cementing medium contained shellac as the main constituent, and alcohol as solvent. Experience has shown, however, that the excellent insulating capacity of the mica is diminished by the use of such binding media. In particular, the layers obtained from separate small laminæ of mica with these lacquers exhibit substantially greater dielectric losses than is the case, for example, with unitary laminæ of native mica of the same dimensions. Experiments have latterly been made to replace shellac by other materials. The use of lacquers with an asphaltum base furnished

layers exhibiting substantially smaller dielectric losses. However, as compared with the binding media with a shellac base, the asphaltum lacquers hitherto known are substantially inferior in adhesive properties. It has been ascertained that the incorporation of gutta-percha imparts a high adhesive property to the asphaltum, without adversely affecting its favourable electrical behaviour. The invention accordingly provides an insulating composition comprising laminæ of laminated insulating material, composed of mica, and a binding medium consisting of asphaltum mixed with gutta-percha. One part by weight of gutta-percha and 2 parts by weight of native asphaltum (such as that known under the registered trade mark "Gilsonite") are triturated together and then 3 parts by weight of benzol are added as solvent. The mixture is warmed on the water bath until solution is complete. In order to prevent loss of benzol, the solution vessel is fitted with a reflux condenser. After it has cooled the mixture is diluted to the desired viscosity with benzol or benzine, and is finally passed through a fine wire sieve to remove mechanical impurities. —*September 22nd*, 1932.

381,061. February 9th, 1932.—Dry Gasholders, E. Grasshoff, Sulzaerstrasse 1, Berlin-Schmargendorf, Germany.

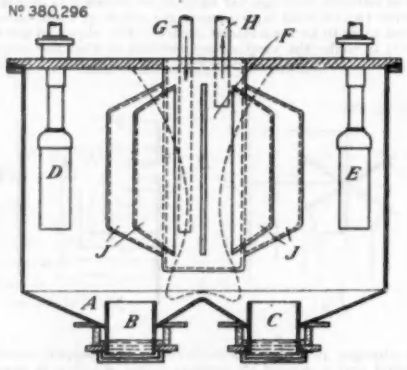
In the case of dry gasholders of the floating disc type, in which the rubbing joint between the disc and the tank is made by means of a flexible packing, it is necessary occasionally to get access to the packing for overhaul or renewal, and it is



undesirable that the holder should be put wholly out of commission during the process. The inventor constructs a working chamber A at the base of the holder, down into which the disc B and its skirt C is lowered. Gas is still kept in the holder beneath the disc, but is prevented from escaping into the working chamber by the sealing device D fixed on a ring round the foundation.—*September 29th*, 1932.

380,296. November 18th, 1931.—Metal Vapour Rectifiers, Siemens-Schuckertwerke Aktiengesellschaft, of Berlin Siemensstadt, Germany.

In accordance with this invention the rectifier A has mercury cathodes arranged in the form of a ring or crown, but only the cathodes B and C are represented in the drawing. Two of the anodes are indicated by D and E. In the centre of the rectifier housing, which is under a vacuum, a cooling body F is inserted, to which cooling medium is supplied through a pipe G and flows



away through a pipe H. The cooling body F is fastened to the cover, which carries the anodes. The cooling body F is furnished with cooling ribs J which serve as cooling surfaces for the mercury vapour arising from the cathodes. The body F, which extends from the cover almost to the cathodes, may consist of a cylinder closed with the exception of the inlet and outlet for the cooling medium and having exterior radial cooling ribs or pockets, which are washed externally by the mercury vapour.—*September 15th*, 1932.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

To-day.

Inst. of British Foundrymen.—Cleveland Scientific and Technical Institute, Middlesbrough. "Furnace Linings," Mr. J. F. Hyslop. 7.45 p.m.

Inst. of Electrical Engineers: London Students.—Savoy-place, W.C.2. "Some of the Less Well-known Methods of Electric Propulsion," Mr. R. J. Eldred. 6.15 p.m.

Inst. of Mechanical Engineers.—Storey's-gate, S.W.1. Informal meeting. Discussion, "Accountancy in Engineering," Major F. L. Watson. 7 p.m.

Inst. of Metals: Sheffield.—In Non-ferrous Section of Applied Science Dept. of University, Sheffield. "Practical Digest on Cluster Mills, Four-high Mills, &c., and Trend of Rolling Mill Design," Mr. E. Williams. 7.30 p.m.

Inst. of Transport.—Station Hotel, Newcastle-upon-Tyne. "An Englishman's Impression of the Italian State Railways," Mr. R. C. V. Ash. 7.30 p.m.

Junior Inst. of Engineers.—39, Victoria-street, S.W.1. Annual General Meeting. 7.30 p.m.

Manchester Association of Engineers.—Engineers' Club, Albert-square, Manchester. "The Relation of the Offices to the Shops," by Mr. F. C. Lawrence. 7.15 p.m.

North-East Coast Inst. of Engineers and Shipbuilders.—Bolbec Hall, Newcastle-upon-Tyne. "Fires at Sea," by Mr. E. Leslie Champness. 6 p.m.

Saturday, November 12th.

Inst. of British Foundrymen.—Technical College, Bradford. Discussion, "Iron Castings *versus* Fabricated Parts," Messrs. A. W. Walker and E. B. Shore. 6.30 p.m.

Inst. of British Foundrymen.—Merchant Venturers' Technical College, Bristol. "Some Methods of Production in a Modern Malleable Ironfoundry," Mr. H. J. Beck. 6.30 p.m.

Inst. of British Foundrymen.—Girls' Welfare Hall, Falkirk Iron Co., Falkirk. "Heat-resisting Cast Iron," Mr. J. W. Donaldson. 6 p.m.

Inst. of Electrical Engineers: London Students.—Visit, Home Office Industrial Museum, Horseferry-road, S.W.1. 3 p.m.

Inst. of Municipal and County Engineers.—Meeting at Deptford Town Hall. 2.15 p.m.

Monday, November 14th.

Bradford Engineering Society.—Technical College, Bradford. "Charnock Night." "Ropes and Chain Drives," by Dr. H. W. Swift. 7.30 p.m.

Chartered Surveyors' Institution.—12, Great George-street, S.W.1. President's address, Mr. C. Gerald Eve. 8 p.m.

Engineers' German Circle (Deutscher Ingenieurbeirkel in London).—At the Inst. of Mech. Engineers, Storey's-gate, S.W.1. "Modern Oil Refinery (Neuzeitliche Erdöl-Aufarbeitung)," Dr.-Ing. R. K. Fischer. 6 p.m.

Inst. of Electrical Engineers: N. Eastern.—Armstrong College, Newcastle-upon-Tyne. "Electric Lighting of Buildings," Messrs. A. B. Read and J. W. T. Walsh. 7 p.m.

Inst. of Metals: Scottish.—39, Elmbank-crescent, Glasgow. "Production of Hot Brass Pressings," Mr. J. W. N. Beard. 7.30 p.m.

Inst. of Production Engineers: Manchester Section.—In the College of Technology, Manchester. "Management in Manufacturing," by Mr. C. T. Skipper. 7.30 p.m.

Inst. of Transport.—At Inst. of Electrical Engineers, Savoy-place, W.C.2. Annual general meeting. "The Licensing System under the Road Traffic Act, 1930—A Review," Mr. E. S. Herbert. 5.30 p.m.

Monday to Saturday, November 14th to 19th.

Public Health Exhibition and Congress.—Royal Agricultural Hall, Islington, N. Daily.

Tuesday, November 15th.

Inst. of Automobile Engineers.—Victoria Hotel, Wolverhampton. "Hydraulic Brakes for Motor Vehicles," Mr. F. G. Parnell. 7.30 p.m.

Inst. of Civil Engineers.—Great George-street, S.W.1. Discussion, "The Willingdon Bridge, Calcutta," Mr. Robert Mair. 6 p.m.

Inst. of Transport.—At Inst. of Electrical Engineers, Savoy-place, W.C.2. Informal. "Can Railway Methods be Improved?" Mr. D. R. Lamb. 6 p.m.

Old Centralians.—The Devereux, Devereux-court, W.C. 2. Luncheon. 1 p.m.

Sheffield Metallurgical Association.—198, West-street, Sheffield. "Controlled Furnace Atmosphere," Dr. E. W. Fell. 7.30 p.m.

Wednesday, November 16th.

Diesel Engine Users Assoc.—Caxton Hall, S.W.1. "Rated Output of Diesel Engines," Mr. W. A. Tookey. 3 p.m.

Electroplaters' and Depositors' Technical Soc.—Northampton Polytechnic, St. John-street, E.C.1. Annual meeting. "Living Organisms in Plating Solutions," Mr. E. A. Ollard. 8.15 p.m.

Inst. of Civil Engineers.—Great George-street, S.W.1. Students. Address, Mr. John Barratt. 6.30 p.m.

Inst. of Civil Engineers: Manchester and District.—36, George-street, Manchester. "New Wharf at Irlam (Manchester Ship Canal)," Mr. H. K. Russell. 6 p.m.

Inst. of Locomotive Engineers (London): Birmingham Centre.—Room 178, Queen's Hotel, Birmingham. "Railway Electrification," by Mr. J. W. Beaty. 6.45 p.m.

Inst. of Production Engineers: Birmingham Section.—Chamber of Commerce, Birmingham. Discussion, "What are the Functions of a Planning Department?" 7 p.m.

Inst. of Welding Engineers.—Inst. of Mech. Engineers, Storey's-gate, S.W.1. "Cutting Steel with Oxygen Machines," Mr. C. G. Bainbridge. 7.45 p.m.

Newcomen Society.—Caxton Hall, S.W.1. Annual general meeting. "Joshua Field's Diary of 1821," Capt. E. C. Smith. 5.30 p.m. Dinner follows meeting.

North-East Coast Inst. of Engineers and Shipbuilders: Graduates' Section.—Bolbec Hall, Newcastle-upon-Tyne. "Design of Electrical Machinery," by Mr. N. H. Denholm. 7.15 p.m.

Royal Meteorological Society.—49, Cromwell-road, S. Kensington, S.W.1. Meeting. 5 p.m.

Royal Microscopical Society.—B.M.A. House, Tavistock-square, W.C.1. Meeting. 5 p.m.

Royal Society of Arts.—John-street, Adelphi, London, W.C.2. "The Economic Possibilities of Rice Grass," Mr. James Bryce. 8 p.m.

Thursday, November 17th.

Inst. of Civil Engineers: Yorkshire.—Hotel Metropole, Leeds. "Main Road Public Lighting," Mr. C. C. Kirby. 7.30 p.m.

Inst. of Electrical Engineers.—Savoy-place, Victoria Embankment, W.C.2. "The Inland Telegraph Service: The Introduction of Modern Machinery and Methods," by Mr. R. P. Smith. 6 p.m.

Inst. of Metals: Birmingham.—University, Birmingham. Discussion, "Heat Treatment without Detrimental Finish." 7 p.m.

Inst. of Production Engineers: Glasgow Section.—In the Inst. of Engineers and Shipbuilders in Scotland, Elmbank-crescent, Glasgow, C.2. "Optical Measurement in Engineering Production," by Mr. A. A. Gigli. 7.45 p.m.

N. East Coast Inst. of Engineers and Shipbuilders: Tees-side Branch.—Cleveland Scientific and Technical Institution, Middlesbrough. "Fires on Ships," Mr. E. L. Champness. 7.30 p.m.

Friday, November 18th.

Inst. of Automobile Engineers.—Park Lane Hotel, Piccadilly, W.1. Annual dinner. 7 for 7.30 p.m.

Inst. of British Foundrymen: Sheffield and District.—Grand Hotel, Sheffield. "Mammoth Castings for the Cunarder Building on the Clyde," Mr. F. Swift. 7.45 p.m.

Inst. of Mechanical Engineers.—Storey's-gate, S.W.1. "Modern Hydraulic Operation of Machine Tools," Mr. H. C. Town. 6 p.m.

Inst. of Welding Engineers.—Chamber of Commerce, Birmingham. "Eye Protection during Welding Operations," Mr. R. B. Butler. 7 p.m.

Junior Inst. of Engineers.—39, Victoria-street, S.W.1. "The Anderson Rotary Piston Steam Engine," Mr. H. P. H. Anderson. 7.30 p.m.

Overhead Lines Association.—Georgian Restaurant, Harrods Stores, Knightsbridge. Third annual Conversazione. 8 p.m.

Saturday, November 19th.

Inst. of Civil Engineers.—Students' visit to Battersea Power Station.

Inst. of British Foundrymen.—Loughborough College, Loughborough. "The Uses of Refractory Materials in the Foundry," Dr. J. G. A. Skerl. 6 p.m.

Inst. of Municipal and County Engineers: S. Eastern.—Meeting at Woking. Council Offices, Woking. 11.30 a.m.

Monday, November 21st.

Hull Association of Engineers.—Beverley-road Baths, Hull. Whist Drive and Dance. 7.15 p.m.

Inst. of Automobile Engineers.—At 39, Elmbank-crescent, Glasgow, C.2. "Hydraulic Brakes for Motor Vehicles," Mr. F. G. Parnell. 7.30 p.m.

Inst. of Electrical Engineers.—Savoy-place, Victoria Embankment, W.C.2. Discussion, on "Loudspeakers." Opener, Dr. N. W. McLachlan. 7 p.m.

Inst. of Mechanical Engineers: Graduates.—Storey's-gate, S.W.1. "Steam Valves," Mr. D. Doulton. 6.15 p.m.

Royal Soc. of Arts.—John-street, Adelphi, W.C.2. Fothergill Trust Lecture, "Fire Fighting," Comm. A. N. G. Firebrace, R.N. (retd.). 8 p.m.

Wolverhampton and District Engineering Society.—Victoria Hotel, Wolverhampton. "Story of Bakelite Resinoid," Mr. G. Dring. 7 p.m.

Tuesday, November 22nd.

British Science Guild.—In the Goldsmiths' Hall, Foster-lane, E.C. Norman Lockyer Lecture, 1932, "Industrial Research and the Nation's Balance Sheet," Sir Frank E. Smith, K.C.B. 4.30 p.m.

Illuminating Engineering Soc.—Visit to Building Centre, Ltd., 158, New Bond-street, W.1. 6 p.m.

Inst. of British Foundrymen.—King's Head Hotel, Coventry. "The Magnetic Moulding Machine," Mr. T. W. Bullock. 7.30 p.m.

Inst. of Electrical Engineers: London Students.—Savoy-place, W.C.2. "Modern Systems of Electrical Installation for Large Buildings," Mr. R. C. W. Joyce. 7 p.m.

Inst. of Electrical Engineers: Scottish.—Grosvenor Restaurant, Gordon-street, Glasgow, C.2. Annual dinner. 6.30 p.m. for 7 p.m.

Inst. of Electrical Engineers: S. Midland Students.—The University, Birmingham. "Electrical Equipment of Warships," Mr. F. C. Duffield. 7 p.m.

Sheffield Metallurgical Association.—198, West-street, Sheffield. "Corrosion Resistance and its Measurements," Mr. H. T. Shirley. 7.30 p.m.

Wednesday, November 23rd.

Inst. of Automobile Engineers.—Engineers' Club, Manchester. "Study of Piston Temperatures and their Relation to Piston Design," Mr. H. Wright Baker. 7 p.m.

Society of Glass Technology: London.—At Works of Rockware Glass Syndicate, Ltd., Greenford. "Refractories for Tank Furnaces," Mr. J. B. Murgatroyd. 7.30 p.m.

Thursday, November 24th.

Inst. of Civil Engineers: Birmingham and District.—Chamber of Commerce, Birmingham. "Research at the Engineering Department of the National Physical Laboratory," Dr. H. J. Gough. 6 p.m.

Inst. of Mechanical Engineers: Yorkshire.—Hotel Metropole, Leeds. "Factory Expense," Mr. J. M. Newton. 7.30 p.m.

Manchester Association of Engineers: Students' Section.—Y.M.C.A. (Restaurant Club Room), Peter-street, Manchester. "Automatic Railway Signalling," by Mr. S. J. Adamson. 7.30 p.m.

Royal Aeronautical Society.—The lecture by Squadron Leader H. Leedham has been postponed.

Friday, November 25th.

Chemical Engineering Group.—Burlington House, W.1. "Problems of Emulsion Persistence," Dr. W. Clayton. 8 p.m.

Manchester Association of Engineers.—Engineers' Club, Albert-square, Manchester. Quarterly meeting. Paper, "Practical Boiler Testing," by Mr. F. Buckingham. 7.15 p.m.

Inst. of Electrical Engineers: S. Midland.—Grand Hotel, Birmingham. Annual dinner. 6.30 for 7 p.m.

Junior Inst. of Engineers.—39, Victoria-street, S.W.1. "Development of Modern Glass Bottle Making Machinery," Mr. F. G. Pasotti. 7.30 p.m.

North-East Coast Inst. of Engineers and Shipbuilders.—Bolbec Hall, Newcastle-upon-Tyne. "Rejuvenation of Ships and their Machinery," by Mr. Andrew Hamilton. 6 p.m.

Soc. of Consulting Marine Engineers and Ship Surveyors: Scottish District.—39, Elmbank-crescent, Glasgow, C.2. Film, "Oxy-acetylene Welding and Cutting." 7 p.m.

Saturday, November 26th.

Inst. of Metals.—Joint meeting with Inst. of British Foundrymen. Armstrong College, Newcastle-upon-Tyne. "New Demands on the Brass Foundry," Mr. J. Arnott. 7.30 p.m.

Monday, November 28th.

Bradford Engineering Society.—Technical College, Bradford. Cinematograph film. "Metal Treatment by the Oxy-acetylene Process." 7.30 p.m.

Royal Soc. of Arts.—John-street, Adelphi, W.C.2. Fothergill Trust Lecture, "Safety of Life from Fire," Lieut.-Col. Guy Symonds, D.S.O. 8 p.m.

Tuesday, November 29th.

Sheffield Metallurgical Association.—198, West-street, Sheffield. "Chromates and Chromium in Relation to the Corrosion of Iron," Dr. U. R. Evans. 7.30 p.m.

Wednesday, November 30th.

Inst. of Civil Engineers: Manchester and District.—36, George-street, Manchester. "Refuse Disposal," Mr. J. T. Kendal. 6 p.m.

Inst. of Welding Engineers.—College of Technology, Manchester. "Flame Cutting by Hand and Machine," Mr. C. G. Bainbridge. 7.30 p.m.

Royal Society of Arts.—John-street, Adelphi, W.C.2. "Recent Developments in Electric Lighting," Mr. W. J. Jones. 8 p.m.

Friday, December 2nd.

Inst. of Mechanical Engineers.—Storey's-gate, S.W.1. Thomas Low Gray Lecture, "Eight Years' Salvage Work at Scapa Flow," Mr. E. F. Cox. 6 p.m.